ESL-TR-06-12-02

ENERGY EFFICIENCY/RENEWABLE ENERGY IMPACT IN THE TEXAS EMISSIONS REDUCTION PLAN (TERP)

SUMMARY REPORT

Annual Report to the
Texas Commission on Environmental Quality

Eduardo J. Ramirez
Kate Champeau
Juan-Carlos Baltazar, Ph.D.
Jeff S. Haberl, Ph.D., P.E.

Energy Systems Laboratory
Texas A&M University System

July 2007

ENERGY SYSTEMS LABORATORY

Texas Engineering Experiment Station
Texas A&M University System

Disclaimer

This report is provided by the Texas Engineering Experiment Station (TEES) pursuant to Section 388.005 and Section 388.003, (2) (A) & (B) of the Texas Health and Safety Code and is distributed for purposes of public information. The information provided in this report is intended to be the best available information at the time of publication. TEES makes no claim or warranty, express or implied that the report or data herein is necessarily error-free. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement, recommendation, or favoring by the Energy Systems Laboratory or any of its employees. The views and opinions of authors expressed herein do not necessarily state or reflect those of the Texas Engineering Experiment Station or the Energy Systems Laboratory.

1 EXECUTIVE SUMMARY

This report is a summary of the renewable energy projects installed throughout Texas after the year 2000. The collection of these projects was done in response to the Energy System Laboratory's requirement to fulfill its obligations for Senate Bill 5 (SB5). The renewable energy projects researched and presented herein include: solar photovoltaic, solar thermal, hydroelectric, geothermal, and landfill gas-fired power plants. However, information on wind energy farms has been omitted in this report due to the fact that a more complete ESL report on this subject has already been prepared, ESL-TR-06-08-01.[1]

In addition to locating these projects, SB5 required the calculation of reduced NOx emissions. To accomplish this, the Energy Systems Laboratory (ESL) at Texas A&M University developed "*eCalc*" in 2004 -- a web-based Emissions Reduction Calculator. This program is able to calculate weather-normalized NOx emissions estimates for energy efficiency and renewable sources projects, such as solar photovoltaic, solar thermal, and wind.

Annual energy savings from renewable projects resulted in the following:[2]

- Solar photovoltaic projects resulted in energy savings of 424.18 MWh/yr and a reduction of 0.28 tons of NOx/year.
- Solar thermal projects resulted in energy savings of 332.88 MWh/yr and a reduction of 0.26 tons of NOx/year.

The peak ozone season day (OSD) NOx reductions were calculated to be:

- Solar photovoltaic projects resulted in savings of 1.29 MWh/day.
- Solar thermal projects resulted in savings equivalent to 0.94 MWh/day.

The emissions reduction values for hydroelectric and geothermal projects are not presented here since there is no methodology in place at this time to obtain these values.

[1] This report excludes wind renewable energy sources. This data can be found in report ESL-TR-06-08-01.
[2] These annual energy savings do include 7% transmissions and distribution losses, but do not include discount or degradations factors.

2 ACKNOWLEDGEMENTS

This work has been completed as a fulfillment of Senate Bill 5, Section 388.003.
The authors thank the following individuals and agencies for gathering specific data and timely input:

Mushtaq Ahmad and Piljae Im of the Energy Systems Laboratory at Texas A&M University; Colin Gates of SWPV; Michael A. Kawecki of the USGBC North Texas Chapter; Tammy Beutnagel, Allen Ognoskie, Judy Gardner, and Judy Robinsheaux from the Guadalupe Blanco River Authority Powerplant; Clayton Church and Floyd E. Boyett from the US Army Corps of Engineers; John Williams from the Lower Colorado River Authority; Big thanks to Richard Carmichael and Amy Boshears from the Texas Commission on Environmental Quality; Jeff Pierce from SCS Engineers; and Robert Comstock from the Texas Parks and Wildlife Department.

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

3 LEGISLATIVE BACKGROUND

In 2001, the 77th Legislature established the Texas Emissions Reduction Plan (TERP) through the enactment of Senate Bill 5. This bill's purpose is to:

- Ensure that the state of Texas meets Federal Clean Air Act requirements per Section 707, Title 42, United States Code.
- Reduce NOx emissions in non-attainment and affected counties through mandatory and voluntary programs.

The TERP identified that Energy Efficiency and Renewable Energy (EE/RE) measures make an important contribution to meeting the above stated goals. In 2003 and 2005, the 78th and 79th Legislatures required the Texas Commission on Environmental Quality (TCEQ) to promote EE/RE as a means to improve air quality standards and to develop a methodology for computing emissions reduction for the State Implementation Plan (SIP) from EE/RE programs. One of the SIP credits requires the Energy Systems Laboratory to report the energy savings and emissions reductions from implementation of new building energy codes to the TCEQ. This was fulfilled with the development of the "Emissions Reduction Calculator (*eCalc*) by the Energy Systems Laboratory. *eCalc* calculates emissions reductions from energy efficiency improvements in residential and commercial construction, municipal projects, and renewable energy projects (Haberl et al. 2006).

SIP-eligible credits were expanded by the 79th Legislature by adding savings from the State Renewable Portfolio Standards from the generation of electricity from renewable sources. Another SIP-eligible credit was expanded by adding savings from the State Renewable Portfolio Standards from the generation of electricity from renewable sources. A specific requirement included the TCEQ to develop methods to quantify emissions reductions from renewable energy. Therefore, this report is a summary of the renewable energy projects implemented in the state Texas.

In 2005, the 79th Legislature amended SB5 to enhance its effectiveness which included requirements to generate 500 MW from non-wind renewables. Therefore, renewable projects were identified to determine how far the state of Texas is from accomplishing this goal.

4 PROJECT CRITERIA

Renewable energy projects throughout the state of Texas were located to determine the NOx emissions reduction. Searches were conducted on four specific categories: solar photovoltaic, geothermal, hydroelectric, and Landfill Gas-fired Power Plants. The criteria for each project included in the data collection were: 1) the installation date was after the year 2000, and 2) the project was installed within the state of Texas. In order to provide a complete record, however, projects reported prior to 2000 were also included.

5 IMPLEMENTATION

An initial search on different internet search engines was conducted to find solar photovoltaic cell, hydroelectric, geothermal, and landfill gas projects. Following these preliminary searches a more thorough investigation was conducted on specific websites that were deemed credible. Most of the project descriptions did not include system specifications data. To find this information, the corresponding companies, organizations, or government entities that were mentioned in the article were contacted via email or phone. Unfortunately, these efforts were productive in only a small number of cases.

In addition to these two main protocols for finding projects, manufacturers and contractors of the various systems were contacted about project installations following the determined criteria.

After the necessary information was obtained, each project was then run through *eCalc*. This program analyzed the energy savings and emissions reduction for each of the projects. Because *eCalc* relies on county designations, it was sometimes necessary to find the nearest geographical county, since not all of the counties in Texas are available in *eCalc*.

6 RENEWABLE ENERGY PROJECTS

6.1 Solar Photovoltaic

The protocol described in the implementation section was conducted first. This prevailed with the discovery of Soltrex, a company that provides data servers, websites, and data loggers to track the performance of PV systems. Within the Soltrex website, several hundred schools across the nation provided the energy output of their PV system, the installation date, and the system specifications.

Another noteworthy source of information was the Meridian Energy Systems, Inc., a company located in Austin, Texas. Their website provided a portfolio that included information about multiple projects completed within the last five to ten years. However, specific information was not provided. Further information regarding all these projects will be provided in a future report.

The Electric Reliability Council of Texas (ERCOT) and State Energy Conservation Office (SECO) also provided information for several projects. Their websites described the use of solar panels at school crossings throughout the site. There were some instances where there was no database for the installation and they could not provide further direction as to where to find it. So, efforts were made to locate specific information on some of these, such as the Sheldon Lake and Environmental Learning Center. The superintendent, Robert Comstock, was contacted for specific information about their PV system. Hensley Field was another project where the project manager, Michael Kawecki, was contacted and replied with a presentation containing more specific information.

After the above sources were exhausted, manufacturers and contractors were contacted to find additional installations. A major contributor for projects was found on a distributor's website, Southwest Photovoltaic Systems, Inc. (SWPV), an international distributor of BP Solar Panels. Their website provides a snapshot of installed projects throughout the United States, so the company was contacted to gain further information on their Texas projects. When asked about the slope of their products used in the qualifying projects, the company could not respond in detail to each one due to time constraints. However, they did inform us that the average solar panel used was 12.5 square feet (5 feet by 2.5 feet). This figure was then used for calculations.

For both of these sources, their corresponding websites cited the type of solar panel installed as well as the number of modules, but the square footage of each module was not available. Since *eCalc* requires the area of the solar panels for each project, it was necessary to find this data. A search was done by contacting the individual manufacturers of these products or were found on the web.

eCalc includes the photovoltaic option for high- or low-end systems. A high-end PV system was assumed for all of the projects based on the average efficiency of the photovoltaic cells in the last decade, which is 11% or higher.

A summary of the different projects and their outputs from *eCalc* can be found in Table 2 and Table 3, respectively. This annual electric savings per county for these projects are presented in Figure 6 and the respective emissions reductions are shown in Figure 8. The number of projects per county is presented in Figure 1.

6.2 Solar Thermal

Information regarding the solar thermal projects was obtained from an ESL survey sent to various companies. Techsun Solar, Inc. is responsible for eight out of the nine projects documented in this report. The ninth one is presented as a special project since there is no methodology currently available to obtain these values. This special project is a Roof Mounted Parabolic Trough collector located at Fort Sam Houston in the San Antonio, Texas, area.

A summary of the different projects and their outputs from *eCalc* can be found in Table 4 and Table 5, respectively. The annual electric savings per county for these projects are presented in Figure 10, and the respective emissions reductions are shown in Figure 12. The number of projects per county is presented in Figure 2.

6.3 Hydroelectric

The main source of information for hydroelectric systems came from the Idaho National Laboratory website that has an interactive map. The user chooses a specific dam; when the dam is chosen, the name, operator, and the capacity of the dam appears. Locations of

twenty-eight dams were found through this process. However, the date of the installation was not available. Further investigation for this information was conducted by contacting the Corps of Engineers and various authorities in charge of each plant including the Guadalupe Blanco River Authority and the Lower Colorado River Authority. Additional private dams such as the Cuero Hydroelectric Power plant were contacted multiple times through several methods with no response.

All hydroelectric project information is presented in Table 7. A Texas map that shows the location of the different projects per county is presented in Figure 3.

6.4 Geothermal

Geothermal projects were found through various websites. Since this did not result in many projects, contractors and manufacturers of geothermal systems were contacted directly to find their projects installed after the year 2000. The Geothermal Heat Pump Consortium's website was used to find contractors of geothermal heat pumps. Six projects were identified in this website; however, more information is needed in order to conduct a more exhaustive analysis that will provide the emissions reduction due to the use of ground-coupled heat pumps. Companies such as Trane, WaterFurnace, and Mammoth, Inc. also provided a few case studies. Once again, the information was limited.

The SMU Geothermal Lab and the Geo-Heat Center from the Oregon Institute of Technology provided general information, but none about any specific project in the Texas area. The president and webpage master did not respond to inquiries about projects installed throughout Texas.

The resulting information can be found in Table 8 with a corresponding map in Figure 4 that shows the number of projects in different counties.

6.5 Landfill Gas-fired Power Plants

House Bill 3415 went into effect in 2001 and encouraged the development and use of landfill gas for state energy and environmental purposes. This allowed TCEQ to give priority to processing applications for registrations.

The City of Denton's landfill has been given various awards for its innovation to produce LGF for biodiesel fuel. This is used to power a three million-gallon biodiesel production facility. This is the first facility of its kind in the world where landfill gas (LGF) is used to produce biodiesel, according to the Environmental Protection Agency (EPA). This LGF supplies all of the energy needs to the production facility including all process heat and power. This biodiesel is then used in part to power the city's truck fleet with B20 which is a blend of 80 % diesel and 20 % biodiesel.

The EPA has a project database for the Landfill Methane Outreach Program (LMOP). The implemented, candidate, and potential projects are listed in Table 9, Table 10, and Table 11, respectively. Figure 5 shows the location of these operational projects implemented throughout Texas.

7 RESULTS

Annual energy savings from renewable projects results:

- Solar photovoltaic projects resulted in energy savings of 424.18 MWh/yr, and a reduction of 0.28 tons of NOx/year.
- Solar thermal projects resulted in energy savings of 332.88 MWh/yr, and a reduction of 0.26 tons of NOx/year.

These reductions do not represent all of the PV and solar thermal projects in the state of Texas. These only reflect the projects documented in the investigated resources. For future reports, the goal is to fill existing gaps in this report and to increase the projects and the resources used to identify different projects.

8 REFERENCES

Haberl, J., Culp, C., Yazdani, B., Gilman, D., Fitzpatrick, T., Muns, S., Verdict, M.; Ahmed, M., Liu, Z., Baltazar-Cervantes, J. C., Degelman, L., Turner, D. 2006. "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP). " Vol. II-Summary Report, Annual Report to the Texas Commission on Environmental Quality, September 2004-December 2005, *Energy Systems Laboratory Report No. ESL-TR-06-06-08*.

Table 1**.** Counties for documented projects.

Assigned Number	County	Assigned Number	County	Assigned Number	County	Assigned Number	County
1	Archer	18	Denton	35	Kimble	52	Tarrant
2	Bastrop	19	DeWitt	36	Kinney	53	Taylor
3	Bexar	20	El Paso	37	Lampasas	54	Tom Green
4	Bosque	21	Fayette	38	Lee	55	Travis
5	Brazoria	22	Fort Bend	39	Llano	56	Uvalde
6	Brazos	23	Galveston	40	Maverick	57	Valverde
7	Brown	24	Gillespie	41	McLennan	58	Victoria
8	Burnet	25	Gonzales	42	Montgomery	59	Ward
9	Caldwell	26	Grayson	43	Newton	60	Washington
10	Calhoun	27	Gregg	44	Nueces	61	Webb
11	Cameron	28	Guadalupe	45	Palo Pinto	62	Wharton
12	Chambers	29	Harris	46	Potter	63	Wichita
13	Childress	30	Harrison	47	Presidio	64	Williamson
14	Collin	31	Hidalgo	48	Randall	65	Wood
15	Colorado	32	Jasper	49	Scurry	66	Zapata
16	Comal	33	Jones	50	Smith	67	Hays
17	Dallas	34	Kendall	51	Sutton		

Table .: Solar Photovoltaic Cell Projects: Data and Information.

Solar Project	City/Town	County	County for ECALC	Date	PV Modules	Capacity(kW)	Total Area (sqft)	Slope	Azimuth (South=180)
Giddings Middle School	Giddings, TX	Lee	Bastrop	Jun-05	GE Energy GEPV-050-M	1	121.4	30	180
La Grange Intermediate School	La Grange, TX	Fayette	Bastrop	May-05	GE Energy GEPV-050-M	1	121.4	30	180
Schulenburg Elementary School	Schulenburg, TX	Fayette	Bastrop	Jun-05	GE Energy GEPV-050-M	1	121.4	30	180
Smithville Junior High School	Smithville, TX	Bastrop	Bastrop	Jun-05	GE Energy GEPV-050-M	1	121.4	30	180
Bastrop Intermediate School	Bastrop, TX	Bastrop	Bastrop	May-07	Sharp Electronics NE-170-U1	1.02	84	35	180
Eagle Pass High School - CC Winn Campus	Eagle Pass, TX	Maverick	Bexar	Feb-02	Siemens SP 75	0.9	81.84	25	180
East Central ISD	San Antonio, TX	Bexar	Bexar	Nov-03	Shell SP-140-PC	1.12	113.92	60	180
James Madison High School	San Antonio, TX	Bexar	Bexar	Feb-02	Siemens SP 75	0.9	81.84	25	180
John Jay High School	San Antonio, TX	Bexar	Bexar	Dec-01	Siemens SP 75	0.9	81.84	60	180
Roosevelt High School	San Antonio, TX	Bexar	Bexar	Mar-04	Shell SP140PC	1.12	113.92	30	180
Utopia ISD	Utopia, TX	Uvalde	Bexar	Jun-05	GE Energy GEPV-050-M	1	121.4	30	180
City Public Services of San Antonio, Northside	San Antonio, TX	Bexar	Bexar	Jul-02	MSX-120	17.28	1699.2	30*	180*
Del Rio High School	Del Rio, TX	Kinney	Bexar	Jul-99	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
Kendall Elementary School	Boerne, TX	Kendall	Bexar	Apr-07	Sharp Electronics NE-170-U2	1.02	84	35	180
Uvalde Junior High School	Uvalde, TX	Uvalde	Bexar	Jul-99	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
City Public Services Primary Control Center	San Antonio, TX	Bexar	Bexar	Jun-04	BP MSX-120	17.28	1699.2	30*	N/A
Institute of Texan Cultures	San Antonio, TX	Bexar	Bexar	N/A	N/A	15	N/A	N/A	N/A
Ft. Sam Houston Bldg. 1350	San Antonio, TX	Bexar	Bexar	Apr-06	N/A	181	N/A	N/A	N/A
Bexar County Jail Annex	San Antonio, TX	Bexar	Bexar	N/A	N/A	N/A	N/A	N/A	N/A
Alvin High School	Alvin, TX	Brazoria	Brazoria	Nov-03	Shell SP-140-PC	1.12	113.92	30	180
El Campo Middle School	El Campo, TX	Wharton	Brazoria	Jul-99	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
Bluebonnet Elementary School	Lockhart, TX	Caldwell	Caldwell	Jul-05	GE Energy GEPV-050-M	1	121.4	30	180
Flatonia Elementary School	Flatonia, TX	Gonzales	Caldwell	May-07	Sharp Electronics NE-170-U1	1.02	84	35	180
Leonard Shanklin Elementary School	Luling, TX	Caldwell	Caldwell	Apr-07	Sharp Electronics NE-170-U4	1.02	84	35	180
Waelder ISD	Waelder, TX	Gonzales	Caldwell	May-07	Sharp Electronics NE-170-U5	1.02	64.08	35	180
Blue Ridge ISD	Blue Ridge, TX	Collin	Collin	Oct-03	Siemens SP 75	0.9	81.84	25	180
McKinney Green Building	McKinney, TX	Collin	Collin	Mar-06	ASE-300-DG-FT	45	3749.76	30*	N/A
Canyon High School	New Braunfels, TX	Comal	Comal	Feb-04	Shell SP140PC	1.12	113.92	20	230
Dallas ISD Environmental Education Center	Seagoville, TX	Dallas	Dallas	Feb-04	Shell Solar SP140PC	1.12	113.92	30	180
The Winston School	Dallas, TX	Dallas	Dallas	N/A	BP XXXXXXX	71	N/A	0	N/A
Childress High School	Childress, TX	Childress	Denton	Jul-99	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
Cordova Middle School	El Paso, TX	El Paso	El Paso	Jan-03	Shell SP140PC	1.12	113.92	25	180
Gene Roddenberry Planetarium	El Paso, TX	El Paso	El Paso	Jun-02	4-kW ASE SunSine AC	3.42	313.44	25	180
Monahans High School	Monahans, TX	Ward	El Paso	Dec-01	Siemens SP 75	0.9	81.84	60	180
Presidio High School	Presidio, TX	Presidio	El Paso	Dec-99	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
Weimar High School	Weimar, TX	Colorado	Fort Bend	May-05	GE Energy GEPV-050-M	1	121.4	30	180
Univeresity of Texas Medical Branch at Galveston	Galveston, TX	Galveston	Galveston	Mar-02	Solarex SX-80U	19.2	1892.88	30*	180*

Table 2 (cont'd.). Solar Photovoltaic Cell Projects: Data and Information.

Solar Project	City/Town	County	County for ECALC	Date	PV Modules	Capacity(kW)	Total Area (sqft)	Slope	Azimuth (South=180)
Pine Tree Junior High School	Longview, TX	Gregg	Gregg	Mar-00	ASE Americas ASE-300-DG/50	4.56	417.92	25	180
Marion Middle School	Marion, TX	Guadalupe	Guadalupe	May-05	GE Energy GEPV-050-M	1	121.4	30	180
Seabrook Intermediate School	Seabrook, TX	Harris	Harris	Nov-03	Shell SP-140-PC	1.12	113.92	60	180
NASA Johnson Space Center	Houston, TX	Harris	Harris	Oct-04	MSX-121	9.72	955.8	30*	180*
UT Health Science Center	Houston, TX	Harris	Harris	Feb-00	Solarex SJ-7500	1.5	271	30*	180*
Aircraft Obstruction Light	Houston, TX	Harris	Harris	N/A	SX65U	N/A	162.6	30*	180*
Learning Center at Sheldon Lake State Park	Houston, TX	Harris	Harris	N/A	BP Solar	170	108.4	40	180*
Learning Center at Sheldon Lake State Park	Houston, TX	Harris	Harris	N/A	N/A	N/A	81.3	25	180*
Hempstead Middle School	Hempstead, TX	Washington	Harris	Apr-07	Sharp Electronics NE-170-U1	1.02	84	35	180
Houston Ship Channel	Houston, TX	Harris	Harris	Sep-00	BP SX65U	0.78	72	30*	N/A
House in Brenham	Brenham, TX	Washington	Harris	Dec-99	Solarex SJ-7500	1.2	N/A	N/A	N/A
Upper Kirby District Center	Houston, TX	Harris	Harris	N/A	BP XXXXXXX	53	N/A	N/A	N/A
Brenham Jr. High School	Brenham, TX	Washington	Harris	Feb-07	Sharp NE-170-U1	1.02	64.08	35	180
Jefferson Middle School	Jefferson, TX	Harrison	Harrison	Sep-99	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
Brooksmith ISD	Brooksmith, TX	Brown	Hood	Nov-01	Siemens SP 75	0.9	81.84	90	180
Abilene School District Planetarium	Abilene, TX	Taylor	Hood	Aug-99	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
Brenham Middle School	Brenham, TX	Washington	Montgomery	Jun-05	GE Energy GEPV-050-M	1	121.4	30	180
Solar Powered Water Pumping	Bryan, TX	Brazos	Montgomery	N/A	Solarex MST-43/mv	N/A	271	30*	180*
Mission High School	Mission, TX	Hidalgo	Nueces	Feb-00	ASE Americas ASE-300-DG/50	4.56	417.92	25	180
Rio Hondo High School	Rio Hondo, TX	Cameron	Nueces	Apr-00	ASE Americas ASE-300-DG/50	4.56	417.92	25	180
Solar Powered Reverse Osmosis in Colorado Acres	Laredo, TX	Webb	Nueces	N/A	BP3150U	7.2	620.64	30*	180*
Calallen High School	Corpus Cristi, TX	Nueces	Nueces	Nov-99	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
Martin High School	Laredo, TX	Webb	Nueces	Oct-99	ASE Americas ASE-300-DG/50	4.56	418.08	0.01	180
Hamlin ISD	Hamlin, TX	Jones	Parker	Nov-01	Siemens SP 75	0.9	81.84	25	180
Holliday ISD	Holliday, TX	Archer	Parker	Dec-01	Siemens SP 75	0.9	81.84	60	180
Ira ISD	Ira, TX	Scurry	Parker	Nov-01	Siemens SP 75	0.9	81.84	60	180
River Road ISD	Amarillo, TX	Potter	Parker	Dec-01	Siemens SP 75	0.9	81.84	60	180
Spring Hill Junior High School	Longview, TX	Smith	Smith	Nov-99	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
Bryker Woods Elementary School	Austin, TX	Travis	Travis	Oct-03	Shell SP-150-PC	1.2	113.92	60	195
Junction High School	Junction, TX	Kimble	Travis	Feb-04	Shell SP-140-PC	1.12	113.92	60	180
Kealing Middle School	Austin, TX	Travis	Travis	Jan-04	Shell SP140PC	1.2	113.92	60	180
Maplewood Elementary School	Austin, TX	Travis	Travis	Oct-01	Siemens SP 75	1.8	163.68	25	180
City Hall, Austin, Texas	Austin, TX	Travis	Travis	xxx-04	PROSOL (type-austin)***	9.74	894.3	30*	180*
Bedichek Middle Shool	Austin, TX	Travis	Travis	Oct-06	Sharp ND-L3EJEA	4.059	352.44	30	180
Blanton Elementary School	Austin, TX	Travis	Travis	Oct-06	Sharp ND-L3EJEA	4.059	352.44	30	180
Cunningham elementary School	Austin, TX	Travis	Travis	Oct-06	Sharp ND-L3EJEA	4.059	352.44	30	180
Garza High School	Austin, TX	Travis	Travis	Oct-06	Sharp ND-L3EJEA	4.059	352.44	30	180
Harper School	Harper, TX	Gillespie	Travis	Mar-07	Sharp Electronics NE-170-U1	1.02	84	35	180
Llano Junior High School	Llano, TX	Llano	Travis	Apr-07	Sharp Electronics NE-170-U5	1.02	84	35	180

Table 2 (cont'd.). Solar Photovoltaic Cell Projects: Data and Information.

Solar Project	City/Town	County	County for ECALC	Date	PV Modules	Capacity(kW)	Total Area (sqft)	Slope	Azimuth (South=180)
Martin Middle School	Austin, TX	Travis	Travis	Oct-06	Sharp ND-L3EJEA	4.059	352.44	30	180
Murchison Middle School	Austin, TX	Travis	Travis	Oct-06	Sharp ND-L3EJEA	4.059	352.44	30	180
O'Henry Middle School	Austin, TX	Travis	Travis	Oct-06	Sharp ND-L3EJEA	4.059	352.44	30	180
Pond Springs Elementary School	Austin, TX	Travis	Travis	Oct-06	Sharp ND-L3EJEA	4.059	352.44	30	180
San Marcos Electric Utility	San Marcos, TX	Travis	Travis	Apr-07	Sharp Electronics NE-170-U5	1.02	64.08	35	180
Sonora High School	Sonora, TX	Sutton	Travis	Dec-99	ASE Americas ASE-300-DG/50	4.56	418.08	15	220
Vliet Residence	Austin, TX	Travis	Travis	Jan-99	Siemens SP 75	1.8	163.92	20	260
Westwood High School	Austin, TX	Travis	Travis	Oct-06	Sharp ND-L3EJEA	4.059	352.44	30	225
Zilker Elementary School	Austin TX	Travis	Travis	Oct-06	Sharp ND-L3EJEA	4.059	352.44	30	180
Courtyard Tennis Club	Austin, TX	Travis	Travis	N/A	N/A	23	N/A	N/A	N/A
Escarpment Village	Austin, TX	Travis	Travis	N/A	N/A	7	N/A	N/A	N/A
IBM	Austin, TX	Travis	Travis	N/A	N/A	22	N/A	N/A	N/A
Hines Pool and Spa	Austin, TX	Travis	Travis	N/A	N/A	21	N/A	N/A	N/A
Centex Beverage Inc.	Austin, TX	Travis	Travis	N/A	N/A	22	N/A	N/A	N/A
Lake Austin Marina	Austin , TX	Travis	Travis	N/A	N/A	21	N/A	N/A	N/A
Habitat Suites	Austin, TX	Travis	Travis	N/A	N/A	17	N/A	N/A	N/A
Palmer events Center	Austin, TX	Travis	Travis	N/A	N/A	36	N/A	N/A	N/A
LCRA Environmental Laboratory	Austin, TX	Travis	Travis	N/A	N/A	22	N/A	N/A	N/A
Austin Bergstrom International Airport	Austin, TX	Travis	Travis	N/A	N/A	32	N/A	N/A	N/A
Sand Hill power Plant, Control Building	Austin, TX	Travis	Travis	N/A	N/A	15	N/A	N/A	N/A
Spring Terrace	Austin, TX	Travis	Travis	N/A	N/A	18	N/A	N/A	N/A
American YouthWorks	Austin, TX	Travis	Travis	N/A	N/A	21	N/A	N/A	N/A
Town Lake Trail Foundation	Austin, TX	Travis	Travis	N/A	N/A	0.5	N/A	N/A	N/A
Garden Terrace	Austin, TX	Travis	Travis	N/A	N/A	21	N/A	N/A	N/A
Vintage Creek learning Center	Austin, TX	Travis	Travis	N/A	N/A	11	N/A	N/A	N/A
Ebeneezer Baptist Church	Austin, TX	Travis	Travis	N/A	N/A	8.4	N/A	N/A	N/A
Sierra Ridge	Austin, TX	Travis	Travis	N/A	N/A	17	N/A	N/A	N/A
Westcave Preserve	Round Mountain, TX	Llano	Travis	N/A	N/A	1.7	N/A	N/A	N/A
St. Andrews Episcopal School	Austin, TX	Travis	Travis	N/A	N/A	22	N/A	N/A	N/A
St. Gabriel Catholic Church	Austin, TX	Travis	Travis	N/A	N/A	21	N/A	N/A	N/A
Hornsby Bend Birding Shelter	Austin, TX	Travis	Travis	N/A	N/A	0.3	N/A	N/A	N/A
Casa Verde	Austin, TX	Travis	Travis	N/A	N/A	1.5	N/A	N/A	N/A
Mineola High School	Mineola, TX	Wood	Upshur	Oct-99	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
Cuero Junior High School	Cuero, TX	DeWitt	Victoria	Jun-05	GE Energy GEPV-050-M	1	121.4	30	180
Solar Powered Water Purification	Matagorda Island, TX	Calhoun	Victoria	N/A	BP585U	N/A	111.23	30*	180*
Central High School	San Angelo, TX	Tom Green	Williamson	Jul-99	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
Davis Elementary School	Round Rock, TX	Williamson	Williamson	Oct-06	Sharp ND-L3EJEA	4.059	352.44	30	180
Lampasas Middle School	Lampasas, TX	Lampasas	Williamson	Apr-07	Sharp Electronics NE-170-U3	1.02	84	35	180

Note: (*) = Assumed

Table 2. Solar Photovoltaic Cell Projects: Energy and NOx Reductions.

		Annual Energy Savings (for base year conditions)							Average per Ozone Season Day (for base year conditions)						
		Annual Energy	1999			2007			Annual Energy	1999			2007		
Project	County for ECALC	Consumption (KWh/yr)	No_x	So_x	CO_2	No_x	So_x	CO_2	Consumption (KWh/yr)	No_x	So_x	CO_2	No_x	So_x	CO_2
Giddings Middle School	Bastrop	1774.00	6.90	3.92	2548.00	2.90	1.62	2286.00	5.00	0.02	0.01	8.00	0.01	0.00	7.00
La Grange Intermediate School	Bastrop	1774.00	6.90	3.92	2548.00	2.90	1.62	2286.00	5.00	0.02	0.01	8.00	0.01	0.00	7.00
Schulenburg Elementary School	Bastrop	1774.00	6.90	3.92	2548.00	2.90	1.62	2286.00	5.00	0.02	0.01	8.00	0.01	0.00	7.00
Smithville Junior High School	Bastrop	1774.00	6.90	3.92	2548.00	2.90	1.62	2286.00	5.00	0.02	0.01	8.00	0.01	0.00	7.00
Bastrop Intermediate School	Bastrop	1212	4.71	2.67	1741	1.98	1.11	1562	4	0.01	0.01	5	0.01	0	4
Eagle Pass High School - CC Winn Campus	Bexar	1207.00	3.18	1.15	1792.00	1.99	1.98	1960.00	4.00	0.01	0.00	6.00	0.01	0.00	6.00
East Central ISD	Bexar	1411.00	3.72	1.34	2096.00	2.33	2.31	2292.00	4.00	0.01	0.00	6.00	0.01	0.00	6.00
James Madison High School	Bexar	1207.00	3.18	1.15	1792.00	1.99	1.98	1960.00	4.00	0.01	0.00	6.00	0.01	0.00	6.00
John Jay High School	Bexar	1013.00	2.67	0.96	1505.00	1.67	1.66	1646.00	3.00	0.01	0.00	4.00	0.00	0.00	4.00
Roosevelt High School	Bexar	1669.00	4.40	1.58	2478.00	2.75	2.73	2711.00	5.00	0.01	0.00	7.00	0.01	0.01	8.00
Utopia ISD	Bexar	1779.00	4.69	1.69	2641.00	2.94	2.91	2889.00	5.00	0.01	0.01	8.00	0.01	0.01	9.00
City Public Services of San Antonio, Northside	Bexar	24895.00	65.67	23.63	36970.00	41.08	40.79	40436.00	75.00	0.20	0.07	112.00	0.12	0.08	120.00
Del Rio High School	Bexar	6165	16.26	5.85	9155	10.17	10.1	10013	19	0.05	0.02	28	0.03	0.02	30
Kendall Elementary School	Bexar	1215	3.21	1.15	1805	2.01	1.99	1974	4	0.01	0	5	0.01	0	6
Uvalde Junior High School	Bexar	6165	16.26	5.85	9155	10.17	10.1	10013	19	0.05	0.02	28	0.03	0.02	30
City Public Services Primary Control Center	Bexar	24895	65.67	23.63	36970	41.08	40.79	40436	75	0.2	0.07	112	0.12	0.08	120
Institute of Texan Cultures	Bexar	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ft. Sam Houston Bldg. 1350	Bexar	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bexar County Jail Annex	Bexar	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alvin High School	Brazoria	1490.00	3.60	3.08	2344.00	2.58	2.00	2106.00	4.00	0.01	0.01	7.00	0.01	0.00	6.00
El Campo Middle School	Brazoria	5513	13.31	11.41	8670	9.54	7.4	7790	17	0.04	0.03	26	0.03	0.02	23
Bluebonnet Elementary School	Caldwell	1774.00	4.93	1.02	2469.00	2.13	0.71	2087.00	5.00	0.01	0.00	7.00	0.01	0.00	6.00
Flatonia Elementary School	Caldwell	1212	3.36	0.7	1687	1.46	0.49	1426	4	0.01	0	5	0	0	4
Leonard Shanklin Elementary School	Caldwell	1212	3.36	0.7	1687	1.46	0.49	1426	4	0.01	0	5	0	0	4
Waelder ISD	Caldwell	925	2.57	0.53	1287	1.11	0.37	1088	3	0.01	0	4	0	0	3
Blue Ridge ISD	Collin	1230.00	4.72	2.73	1777.00	2.00	1.12	1586.00	4.00	0.01	0.01	6.00	0.01	0.00	5.00
McKinney Green Building	Collin	56096	215.35	124.75	81061	91.21	50.98	72330	171	0.66	0.38	248	0.28	0.07	213
Canyon High School	Comal	1681.00	4.43	1.60	2496.00	2.77	2.75	2730.00	5.00	0.01	0.01	8.00	0.01	0.01	8.00
Dallas ISD Environmental Education Center	Dallas	1704.00	6.62	3.76	2448.00	2.79	1.56	2196.00	5.00	0.02	0.01	7.00	0.01	0.00	6.00
The Winston School	Dallas	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Childress High School	Denton	6284	24.12	13.98	9081	10.22	5.71	8103	20	0.08	0.04	28	0.03	0.01	24
Cordova Middle School	El Paso	2008.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00
Gene Roddenberry Planetarium	El Paso	5525.00	0.00	0.00	0.00	0.00	0.00	0.00	16.00	0.00	0.00	0.00	0.00	0.00	0.00
Monahans High School	El Paso	1240.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00
Presidio High School	El Paso	7370	0	0	0	0	0	0	21	0	0	0	0	0	0

Table 3 (cont'd.). Solar Photovoltaic Cell Projects: Energy and NOx Reductions.

		Annual Energy Savings (for base year conditions)							Average per Ozone Season Day (for base year conditions)						
		Annual Energy	1999			2007			Annual Energy	1999			2007		
Project	County for ECALC	Consumption (KWh/yr)	No_x	So_x	CO_2	No_x	So_x	CO_2	Consumption (KWh/yr)	No_x	So_x	CO_2	No_x	So_x	CO_2
Weimar High School	Fort Bend	1588.00	3.84	3.25	2490.00	2.77	2.16	2249.00	5.00	0.01	0.01	7.00	0.01	0.01	7.00
Univeresity of Texas Medical Branch at Galveston	Galveston	24763.00	59.80	51.24	38942.00	42.85	33.23	34990.00	74.00	0.18	0.15	116.00	0.12	0.08	101.00
Pine Tree Junior High School	Gregg	5747.00	0.00	0.00	0.00	0.00	0.00	0.00	18.00	0.00	0.00	0.00	0.00	0.00	0.00
Marion Middle School	Guadalupe	1779.00	4.69	1.69	2641.00	2.94	2.91	2889.00	5.00	0.01	0.01	8.00	0.01	0.01	9.00
Seabrook Intermediate School	Harris	1255.00	2.10	1.77	1358.00	1.51	1.18	1226.00	3.00	0.01	0.00	4.00	0.00	0.00	3.00
NASA Johnson Space Center	Harris	12504.00	20.87	17.66	13.53	15.04	11.75	12216.00	37.00	0.06	0.05	40.00	0.04	0.03	35.00
UT Health Science Center	Harris	3545.00	5.92	5.01	3835.00	4.26	3.33	3464.00	11.00	0.02	0.01	11.00	0.01	0.01	10.00
Aircraft Obstruction Light	Harris	2127.00	3.65	3.00	2301.00	2.56	2.00	2078.00	6.00	0.01	0.01	7.00	0.01	0.00	6.00
Learning Center at Sheldon Lake State Park	Harris	1372.00	2.29	1.94	1484.00	1.65	1.29	1340.00	4.00	0.01	0.01	4.00	0.00	0.00	4.00
Learning Center at Sheldon Lake State Park	Harris	1072.00	1.79	1.51	1160.00	1.29	1.01	1048.00	3.00	0.01	0.00	4.00	0.00	0.00	3.00
Hempstead Middle School	Harris	1083	1.81	1.53	1171	1.3	1.02	1058	3	0.01	0	3	0	0	3
Houston Ship Channel	Harris	942	1.57	1.33	1019	1.13	0.89	920	3	0	0	3	0	0	3
House in Brenham	Harris	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Upper Kirby District Center	Harris	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Brenham Jr. High School	Harris	826	1.38	1.17	893	0.99	0.78	807	2	0	0	3	0	0	2
Jefferson Middle School	Harrison	5749	0	0	0	0	0	0	18	0	0	0	0	0	0
Brooksmith ISD	Hood	670.00	2.57	1.49	969.00	1.09	0.61	864.00	1.00	0.01	0.00	2.00	0.00	0.00	2.00
Abilene School District Planetarium	Hood	6284	24.12	19.98	9081	10.22	5.71	8103	20	0.08	0.04	28	0.03	0.01	24
Brenham Middle School	Montgomery	1588.00	2.65	2.24	1718.00	1.91	1.49	1552.00	5.00	0.01	0.01	5.00	0.01	0.00	4.00
Solar Powered Water Pumping	Montgomery	3545.00	5.92	5.01	3835.00	4.26	3.33	3464.00	11.00	0.02	0.01	11.00	0.01	0.01	10.00
Mission High School	Nueces	5565.00	15.45	3.20	7746.00	6.68	2.23	6546.00	17.00	0.05	0.01	24.00	0.02	0.00	20.00
Rio Hondo High School	Nueces	5565.00	15.45	3.20	7746.00	6.68	2.23	6546.00	17.00	0.05	0.01	24.00	0.02	0.00	20.00
Solar Powered Reverse Osmosis in Colorado Acres	Nueces	8187.00	22.73	4.70	11395.00	9.83	3.28	9630.00	25.00	0.07	0.01	35.00	0.03	0.01	28.00
Calallen High School	Nueces	5567	15.45	3.2	7748	6.68	2.23	6549	17	0.05	0.01	24	0.02	0	20
Martin High School	Nueces	5373	14.91	3.09	7478	6.45	2.15	6320	18	0.05	0.01	25	0.02	0	20
Hamlin ISD	Parker	1230.00	4.78	2.71	1766.00	2.01	1.13	1585.00	4.00	0.01	0.01	6.00	0.01	0.00	5.00
Holliday ISD	Parker	1047.00	4.07	2.31	1504.00	1.71	0.96	1349.00	3.00	0.01	0.01	4.00	0.00	0.00	3.00
Ira ISD	Parker	1047.00	4.07	2.31	1504.00	1.71	0.96	1349.00	3.00	0.01	0.01	4.00	0.00	0.00	3.00
River Road ISD	Parker	1047.00	4.07	2.31	1504.00	1.71	0.96	1349.00	3.00	0.01	0.01	4.00	0.00	0.00	3.00
Spring Hill Junior High School	Smith	5749	22.35	12.69	8258	9.4	5.26	7408	18	0.07	0.04	26	0.03	0.01	22
Bryker Woods Elementary School	Travis	1404.00	5.39	3.03	2014.00	2.28	1.26	1807.00	4.00	0.01	0.01	5.00	0.01	0.00	5.00
Junction High School	Travis	1404.00	5.39	3.03	2014.00	2.28	1.26	1807.00	4.00	0.01	0.01	5.00	0.01	0.00	5.00
Kealing Middle School	Travis	1404.00	5.39	3.03	2014.00	2.28	1.26	1807.00	4.00	0.01	0.01	5.00	0.01	0.00	5.00
Maplewood Elementary School	Travis	2408.00	9.25	5.20	3455.00	3.91	2.17	3100.00	7.00	0.03	0.02	11.00	0.01	0.00	9.00
City Hall, Austin, Texas	Travis	13069.00	50.19	28.24	18747.00	21.23	11.75	16821.00	39.00	0.15	0.09	57.00	0.06	0.02	49.00
Bedichek Middle Shool	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
Blanton Elementary School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
Cunningham elementary School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
Garza High School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19

Table 3 (cont'd.). Solar Photovoltaic Cell Projects: Energy and NOx Reductions.

		Annual Energy Savings (for base year conditions)							Average per Ozone Season Day (for base year conditions)						
		Annual Energy	1999			2007			Annual Energy	1999			2007		
Project	County for ECALC	Consumption (KWh/yr)	No_x	So_x	CO_2	No_x	So_x	CO_2	Consumption (KWh/yr)	No_x	So_x	CO_2	No_x	So_x	CO_2
Harper School	Travis	1212	4.65	2.62	1739	1.97	1.09	1560	4	0.01	0.01	5	0.01	0	4
Llano Junior High School	Travis	1212	4.65	2.62	1739	1.97	1.09	1560	4	0.01	0.01	5	0.01	0	4
Martin Middle School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
Murchison Middle School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
O'Henry Middle School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
Pond Springs Elementary School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
San Marcos Electric Utility	Travis	925	3.55	2	1326	1.5	0.83	1190	3	0.01	0.01	4	0	0	3
Sonora High School	Travis	6131	23.54	13.25	8795	9.96	5.51	7891	20	0.07	0.04	28	0.03	0.01	24
Vliet Residence	Travis	2415	9.27	5.22	3465	3.92	2.17	3109	8	0.03	0.02	11	0.01	0	9
Westwood High School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
Zilker Elementary School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
Courtyard Tennis Club	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Escarpment Village	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IBM	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hines Pool and Spa	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Centex Beverage Inc.	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lake Austin Marina	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Habitat Suites	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Palmer events Center	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LCRA Environmental Laboratory	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Austin Bergstrom International Airport	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sand Hill power Plant, Control Building	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Spring Terrace	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
American YouthWorks	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Town Lake Trail Foundation	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Garden Terrace	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vintage Creek learning Center	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ebeneezer Baptist Church	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sierra Ridge	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Westcave Preserve	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
St. Andrews Episcopal School	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
St. Gabriel Catholic Church	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hornsby Bend Birding Shelter	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Casa Verde	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mineola High School	Upshur	5749	0	0	0	0	0	0	18	0	0	0	0	0	0
Cuero Junior High School	Victoria	1624.00	4.51	0.93	2260.00	1.95	0.65	1910.00	5.00	0.01	0.00	7.00	0.01	0.00	6.00
Solar Powered Water Purification	Victoria	1488.00	4.13	0.86	2071.00	1.79	0.60	1750.00	4.00	0.01	0.00	6.00	0.01	0.00	5.00
Central High School	Williamson	6151	23.62	13.29	8824	9.99	5.53	7917	19	0.07	0.04	27	0.03	0.01	23
Davis Elementary School	Williamson	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
Lampasas Middle School	Williamson	1212	4.65	2.62	1739	1.97	1.09	1560	4	0.01	0.01	5	0.01	0	4
TOTAL		396467.00	1151.65	618.50	504339.53	566.73	379.78	483511.00	1206.00	3.46	1.78	1565.00	1.75	0.66	1413.00

Note: Nox, Sox, and CO_2 emissions reductions are zero for not ERCOT counties (El Paso, Harrison,Gregg, and Upshur).

Table 3. Solar Thermal Projects.

City	County	County for eCalc	Project Purpose	Model	Total Area (sqft)	Slope (degree)	Azimuth (i.e. South=0, West (-) and East (+))	Fluid
Austin	Travis	Travis	Domestic Hot Water (DHW)	N/A	N/A	N/A	0	Antifreeze
Austin	Travis	Travis	Domestic Hot Water (DHW)	SS HX Drainback	78.75	20	0	Water
Round Rock	Willamson	Willamson	Domestic Hot Water (DHW)	SS HX Drainback	52.5	20	-90	Water
Dripping Springs	Hays	Hays	Domestic Hot Water (DHW)	SS HX Drainback	52.5	20	20	Water
San Antonio	Bexar	Bexar	Domestic Hot Water (DHW)	SS HX Drainback	52.5	20	0	Water
San Antonio	Bexar	Bexar	Pool Heating System	FS collector	256	20	-45	Water
N/A	N/A	N/A	Domestic Hot Water (DHW)	SS HX Drainback	78.75	20	-45	Water
N/A	N/A	N/A	Domestic Hot Water (DHW)	SS HX Drainback	52.5	20	-45	Water

Table 4. Solar Thermal Projects Emissions Reduction.

		Annual Energy Savings (for base year conditions)							Average per Ozone Season Day (for base year conditions)						
		Annual Energy	1999			2007			Annual Energy Consumption	1999			2007		
Project	County for ECALC	Consumption (KWh/yr)	No_x	So_x	CO_2	No_x	So_x	CO_2	(KWh/yr)	No_x	So_x	CO_2	No_x	So_x	CO_2
1	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Travis	4134	15.87	8.93	5930	6.71	3.72	5320	14	0.05	0.03	20	0.02	0.01	17
3	Willamson	3211	12.33	6.94	4606	5.22	2.89	4133	13	0.05	0.03	18	0.02	0	16
4	Hays	3469	9.16	2.44	4791	4.41	1.14	4234	12	0.03	0.01	17	0.02	0	15
5	Bexar	3469	9.15	3.29	5152	5.73	5.68	5635	12	0.03	0.01	18	0.02	0.01	19
6	Bexar	26235	69.2	24.9	38960	43.3	42.98	42.612	87	0.23	0.08	130	0.14	0.09	140
7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL		40518	115.71	46.5	59439	65.37	56.41	19364.6	138	0.39	0.16	203	0.22	0.11	207

Table 5. Solar Thermal Special Project.

Special Case	
Location	Fort Sam Houston, San Antonio TX
Date	Jun-03
Collector	Roof Mounted Parabolic Trough
Number of collectors	129
Total Aperture area (sqft)	4515
Maximum operation temperature (°F)	400
Annual Energy Consumption (KWh/yr)	270583
Annual Energy Consumption OSD (KWh/yr)	741.3

Table 6. Hydroelectric Plant Information.

Hydropower Plant	County	Operator	District per IDL*	Date Built	Capacity (MW)
Abbott TP-3	Victoria	Guadalupe Blanco River Authority	12	1920/30's	2.8
Amistad	Valverde	Intl Bndry and water commission	13	1969	66
Austin (Miller)	Lampasas	Lower Colorado River Authority	12	1938	13.4
Buchanan 3	Burnet	Lower Colorado River Authority	12	1931	22.5
Buchanan	Burnet	Lower Colorado River Authority	12	1931	11.25
Canyon	Randall	Guadalupe Blanco River Authority	12	1989	6.07
Cuero	Dewitt	Cuero Hydroelectric	12	Historical Register 1977	1.125
Denison	Grayson	Corps of Engineergs	11	1940's	70
Dunlap TP 1	Guadalupe	Guadalupe Blanco River Auth	12	1920/30's	3.6
Eagle Pass	Maverick	Central Power and LT Co	13	1930's	9.6
Falcon	Zapata	Intl Bndry and water commission	13	1953	31.5
Gonzales	Gonzales	Gonzales	12	1925	1.14
H-4 (Lake Gonzales)	Guadalupe	Guadalupe Blanco River Auth	12	1920/30's	2.4
H-5 (Lake Wood)	Guadalupe	Guadalupe Blanco River Auth	12	1920/30's	2.4
Inks	Burnet	Lower Colorado River Authority	12	1936	12.5
LB Johnson (Wirtz)	Burnet	Lower Colorado River Authority	12	1949	45
Lewisville	Denton	Denton	12	N/A	2
Mansfield	Burnet	Lower Colorado River Authority	12	1937	83.7
Max Starcke	Burnet	Lower Colorado River Authority	12	1949	30
Morris Sheppard	Palo Pinto	Brazos River Authority	12	N/A	22.5
Nolte (TP- 5/Meadow Lake)	Williamson	Guadalupe Blanco River Auth	12	1920/30's	2.4
Ray Roberts	Grayson	Denton	12	N/A	1.2
Sam Rayburn	Jasper	Corps of Engineergs	12	1956	52
Seguin	Guadalupe	Seguin	12	N/A	0.25
Toledo Bend	Newton	Sabine R Authority LA & Tex	12	N/A	80.75
Town Bluff	Jasper	Corps of Engineergs	12	1989	8
TP 4	Guadalupe	Guadalupe Blanco River Auth	12	1920/30's	2.4
Whitney	Bosque	Corps of Engineergs	12	1955	30
Total capacity					**616.485**

*Note: IDL is the Idaho National Laboratory which supports the U.S. Department of Energy's energy research.

Table 7. Geothermal Heat Pump Energy Projects.

Project	County	Implementation Date	Capacity (ton)	Area (sqft)
Birdville High School Campus	Denton	2001	N/A	N/A
Texas Motor Speedway	Denton	1998	N/A	N/A
George W. Bush's ranch	McLennan	2001	14	N/A
Esperanza del Sol, Dallas (Hope of the Sun)	Dallas	1994	18	15276
Hillside Oaks, East Dallas	Dallas	1997	366	276120
Pease Elementary School, Austin	Travis	1997	90	39162
Brooke Elementary School	Travis	1997	150	51605
Govalle Elementary School	Travis	1997	230	89319
Bailey Middle School, Austin	Travis	1997	512	200000
Home in Iowa Park	Wichita	1997	1	1668
The Home of the Future	Dallas	1997	13	4573

Table 8. Landfill Gas-fired Power Plants: Operational.

Landfill Name	City	County	Waste In Place (tons)	Landfill Owner Organization	Project Status	Project Start Date	MW Capacity	LFG Flow to Project (SCFD)	Emission Reductions (MTCO2)
Arlington LF	Arlington	Tarrant	13,981,144	City of Arlington	Operational	6/1/2001	5.0	1.584	0.217
BFI - Tessman Road Landfill	San Antonio	Bexar	11,300,000	Allied Waste Services	Operational	10/10/2002	5.4	2.900	0.234
BFI - Tessman Road Landfill	San Antonio	Bexar	11,300,000	Allied Waste Services	Operational	5/1/2003	2.7	1.450	0.117
Blue Bonnet LF	Houston	Harris	2,526,000	Waste Management, Inc.	Operational	3/1/2003	1.9	0.928	0.084
Castle Road Landfill	Garland	Dallas	4,012,500	City of Garland	Operational	5/1/2000	N/A	N/A	0.089
City of Austin LF	Austin	Travis	4,858,500	City of Austin, TX	Operational	2/1/2004	0.2	N/A	0.009
City of Brownwood Landfill	Brownwood	Brown	1,300,100	City of Brownwood	Operational	1/1/1998	N/A	N/A	0.035
City of Conroe LF	Conroe	Montgomery	3,146,000	City of Conroe	Operational	3/1/2003	2.9	N/A	0.126
City of Waco LF	Woodway	McLennan	2,225,000	City of Waco	Operational	3/1/2004	1.5	1.000	0.065
Coastal Plains LF	Alvin	Galveston	6,546,410	Waste Management, Inc.	Operational	1/10/2003	6.7	N/A	0.289
Covel Gardens LF	San Antonio	Bexar	12,007,000	Waste Management, Inc.	Operational	12/1/2005	9.6	N/A	0.416
Dallas-Fort Worth LF	Dallas	Denton	18,388,100	Waste Management, Inc.	Operational	1/1/1992	6.6	N/A	0.286
Denton Sanitary Landfill	Denton	Denton	2,266,664	City of Denton, TX	Operational	2/1/2005	N/A	0.432	0.035
McCarty Road LF	Houston	Harris	28,918,718	Allied Waste Services	Operational	1/1/1986	N/A	N/A	0.797
McCommas Bluff LF/City of Dallas	Dallas	Dallas	26,470,000	City of Dallas, TX	Operational	1/1/2000	N/A	N/A	0.772
Rosenberg Landfill	Rosenberg	Fort Bend	2,649,100	Fort Bend County, TX	Operational	1/1/2000	N/A	1.000	0.082
Sanifill Of Texas-Baytown LF	Baytown	Chambers	6,290,000	Waste Management, Inc.	Operational	1/24/2003	3.9	1.730	0.169
Security Recycling and Disposal LF	Cleveland	Montgomery	4,014,800	Waste Management, Inc.	Operational	5/1/2003	5.0	N/A	0.217
Sunset Farms	Austin	Travis	9,600,000	Allied Waste Services	Operational	12/1/1996	3.0	1.500	0.130
WMI/Atascocita LF	Humble	Harris	9,628,700	Waste Management, Inc.	Operational	6/1/2003	8.5	3.090	0.368
WMI/Atascocita LF	Humble	Harris	9,628,700	Waste Management, Inc.	Operational	1/1/2004	1.7	0.620	0.074
Denton Sanitary Landfill	Denton	Denton	2,266,664	City of Denton, TX	Construction	9/1/2006	1.5	0.860	0.065
Fort Worth Regional LF	Haltom City	Tarrant	N/A	Allied Waste Services	Construction	3/15/2006	1.6	0.720	0.069
McCommas Bluff LF/City of Dallas	Dallas	Dallas	26,470,000	City of Dallas, TX	Construction	7/1/2006	22.0	N/A	0.953
Austin Community LF	Austin	Travis	10,380,188	Waste Management, Inc.	Shutdown	1/1/1998	N/A	N/A	N/A

SCFD = Million of standard cubic feet
MTCO2 = Million Tons of CO2

Table 9. Landfill Gas-Fired Power Plants: Candidates.

Landfill Name	City	County	Waste In Place (tons)	Year Landfill Opened	Landfill Closure Year	Landfill Owner Organization
Services LLC	Altair	Colorado	9,195,000	1988	2004	Clean Harbors
Amarillo LF	Amarillo	Potter	7,031,400	1976	2050	City of Amarillo
LF	Austin	Travis	10,380,188	1977	2001	Waste Management, Inc.
Landfill	Abilene	Jones	7,921,300	1982	2067	Ray Knowles
Blue Ridge LF	Fresno	Fort Bend	4,113,900	1993	2025	Allied Waste Services
Disposal LF	Angleton	Brazoria	6,279,700	1993	2050	Republic Services, Inc.
SWMA Landfill	Brian & College Station	Brazos	3,009,600	1981	2007	Brazos Valley SWMA
C&T Landfill	Linn	Hidalgo	3,844,000	1976	2004	Duncan Disposal, Inc.
Camelot Landfill	Lewisville	Denton	6,044,700	1981	2019	City of Farmers Branch
Landfill	Odessa	Ector	1,300,000	N/A	N/A	Republic Services, Inc.
LF	Beaumont	Jefferson	2,868,800	1983	2021	City of Beaumont
Prairie LF	Grand Prairie	Dallas	2,835,800	1977	2021	City of Grand Prairie
Landfill	Irving	Dallas	2,063,900	1981	2065	City of Irving, TX
City of Laredo LF	Laredo	Webb	3,180,000	1986	2015	City of Laredo
City of Lubbock LF	Lubbock	Lubbock	2,177,800	1975	2008	City of Lubbock
LF	Mckinney	Collin	3,957,000	1980	2004	City of McKinney
City Of Midland LF	Midland	Midland	3,053,200	1990	2170	City of Midland
Nacogdoches	Nacogdoches	Nacogdoches	1,296,200	1977	2033	City of Nacogdoches
City of Pampa LF	Pampa	Gray	1,176,200	1975	2007	City of Pampa
Landfill	Perryton	Ochiltree	1,631,100	1979	2006	City of Perryton
Landfill	Port Arthur	Jefferson	1,802,100	1986	2044	City of Port Arthur
LF	Sweetwater	Nolan	1,283,800	1976	2040	City of Sweetwater
Landfill	Temple	Bell	3,600,000	N/A	N/A	City of Temple
Landfill	Bloomington	Victoria	2,556,000	1982	2040	City of Victoria
Weatherford LF	Weatherford	Parker	1,079,000	1976	2060	IESI, Inc.
Falls LF	Wichita Falls	Wichita	4,073,200	1982	2021	City of Wichita Falls
Clint LF	Clint	El Paso	4,904,400	1983	2006	City of El Paso
Landfill	Colorado City	Mitchell	1,545,200	1975	2020	City of Colorado City
Comal County LF	New Braunfels	Comal	3,817,620	1975	2010	Waste Management, Inc.
Landfill	Avalon	Ellis	4,254,250	1985	2100	Republic Services, Inc.
Eastside Landfill	Fort Worth	Tarrant	N/A	N/A	N/A	Waste Management, Inc.
Southeast Landfill	Kennedale	Tarrant	5,299,400	1976	2036	City of Fort Worth, TX
LF	Alta Loma	Galveston	7,822,500	1973	2025	Allied Waste Services
Landfill	Beaumont	Jefferson	2,310,400	1991	2021	Allied Waste Services
Landfill	Tyler	Smith	3,087,300	1989	2020	City of Tyler
Hillside Landfill	Sherman	Grayson	2,526,400	1981	2023	Waste Management, Inc.
J.C. Elliot LF	Corpus Christi	Nueces	5,717,100	1972	2005	City of Corpus Christi, TX
Lacy-Lakeview LF	Waco	McLennan	1,306,200	1985	2020	Waste Management, Inc.
McCombs LF	El Paso	El Paso	4,137,100	1984	2046	City of El Paso
Mill Creek LF	Fort Worth	Tarrant	4,815,500	1973	2002	Allied Waste Services
Nelson Gardens LF	San Antonio	Bexar	11,800,000	1980	1993	City of San Antonio
Waste/Maxwell	Plano	Collin	6,083,700	1982	2004	North Texas Municipal Water District
Pine Hill LF	Longview	Gregg	12,141,700	1982	2060	4S Oil Company
Landfill	Jacksonville	Cherokee	1,044,200	1983	2030	Allied Waste Services
Skyline LF	Ferris	Ellis	8,191,000	1942	2040	Waste Management, Inc.
(Amarillo)	Canyon	Randall	3,393,200	1987	2025	Allied Waste Services
County LF	Sugarland	Fort Bend	1,664,372	1981	2020	The Sprint Companies
Sprint LF	Sugarland	Harris	2,041,600	1987	2005	Landfill Owner
Systems LF	Austin	Travis	4,408,900	1990	2050	Texas Disposal Systems
Environmental	Altair	Colorado	1,980,400	1976	2002	Safety Clean
Landfill	Dallas	Dallas	6,838,600	1969	2003	Allied Waste Services
Turkey Creek LF	Alvarado	Johnson	3,733,200	1983	2025	Allied Waste Services
LF	Aledo	Tarrant	9,955,600	1977	2005	Waste Management, Inc.
LF	Houston	Harris	6,405,000	1978	2017	Allied Waste Services
LF	Hutto	Williamson	2,134,700	1981	2040	Waste Management, Inc.
Systems Inc. LF	Alvin	Galveston	3,202,900	1994	2022	Waste Management, Inc.

Table 10. Landfill Gas-fired Power Plants: Potential.

Landfill Name	City	County	Waste In Place (tons)	Year Landfill Opened	Landfill Closure	Landfill Owner
Bell County/Sparks LF	Belton	Bell	343,200	1994	2001	Bell County
Bell Processing Inc. LF	Wichita Falls	Wichita	N/A	1990	2001	Bell Processing Inc
Best Pak Disposal Inc. LF	Pattison	Waller	N/A	N/A	2001	Waste Management, Inc.
BFI LF	Abilene	Taylor	745,888	1993	1997	Pine Street Salvage Company
City of Cleburne Landfill	Cleburne	Johnson	1,583,200	1976	N/A	Landfill Owner
City of Corsicana LF	Corsicana	Navarro	788,100	1993	2100	Landfill Owner
City of Richardson LF	Richardson	Collin	825,218	1975	1990	City of Richardson
ECD Landfill	Ennis	Ellis	N/A	1988	2089	Allied Waste Services
El Centro Landfill	Robstown	Nueces	N/A	2000	2013	Allied Waste Services
Ellis County LF	Palmer	Ellis	892,320	1994	N/A	Waste Management, Inc.
Gulfwest Facility	Anahuac	Chambers	N/A	1993	2017	Allied Waste Services
Hazelwood Enterprises, Inc. LF	N/A	N/A	N/A	N/A	N/A	Landfill Owner
Hutchins Landfill	Hutchins	Dallas	1,000,000	1978	1992	Allied Waste Services
Itasca Landfill	Itasca	Hill	N/A	1977	2017	Allied Waste Services
Kerrville Landfill	Kerrville	Kerr	N/A	1985	2006	City of Kerrville
Laidlaw/Wilmer LF	Wilmer	Dallas	686,400	1992	2001	Landfill Owner
Lewisville Landfill	Lewisville	Denton	N/A	1986	2003	Allied Waste Services
Maloy Landfill	Commerce	Hunt	610,000	1979	2030	Republic Services, Inc.
Mexia Landfill	Mexia	Limestone	N/A	1983	2019	Allied Waste Services
New Boston Landfill	New Boston	Bowie	N/A	N/A	N/A	N/A
Newton County Landfill	Mauriceville	Newton	N/A	N/A	N/A	N/A
North County C&D Landfill	League City	Galveston	N/A	N/A	N/A	Republic Services, Inc.
Paris Landfill	Paris	Lamar	N/A	N/A	N/A	N/A
Pecan Prairie Landfill	Kingston	Hunt	1,479,900	1984	1998	Waste Management, Inc.
Pleasant Oaks Landfill	Mount Pleasant	Titus	N/A	1960	2012	City of Mount Pleasant
Quail Canyon	Lubbock	Lubbock	200,200	1977	1993	Allied Waste Services
Rio Grande Valley	Donna	Hidalgo	N/A	N/A	N/A	Allied Waste Services
Sinton	Sinton	San Patricio	N/A	1972	2002	Allied Waste Services
Trashaway San Angelo Landfill	San Angelo	Tom Green	790,000	1984	N/A	Republic Services, Inc.

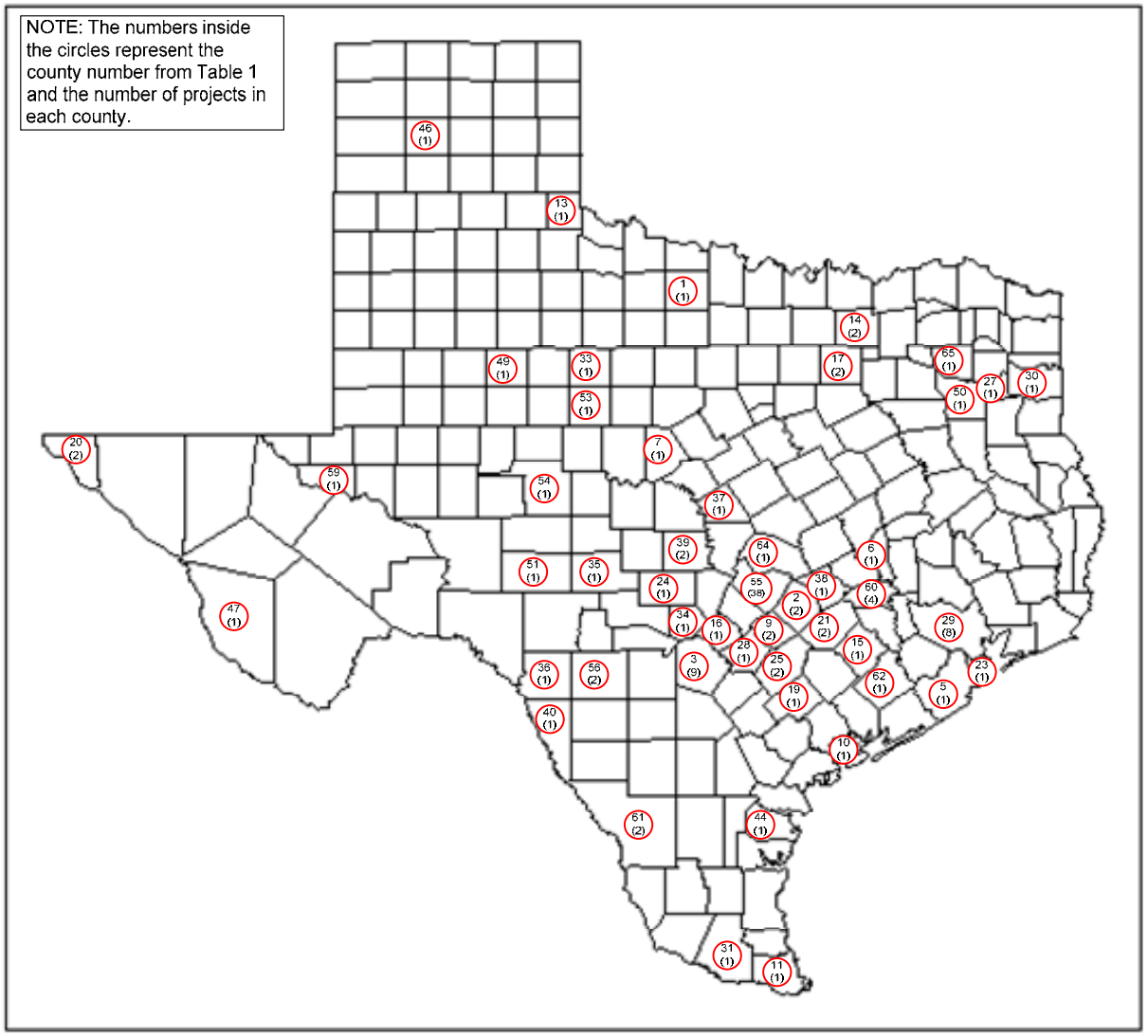

Figure 1. Solar Photovoltaic Projects throughout Texas.

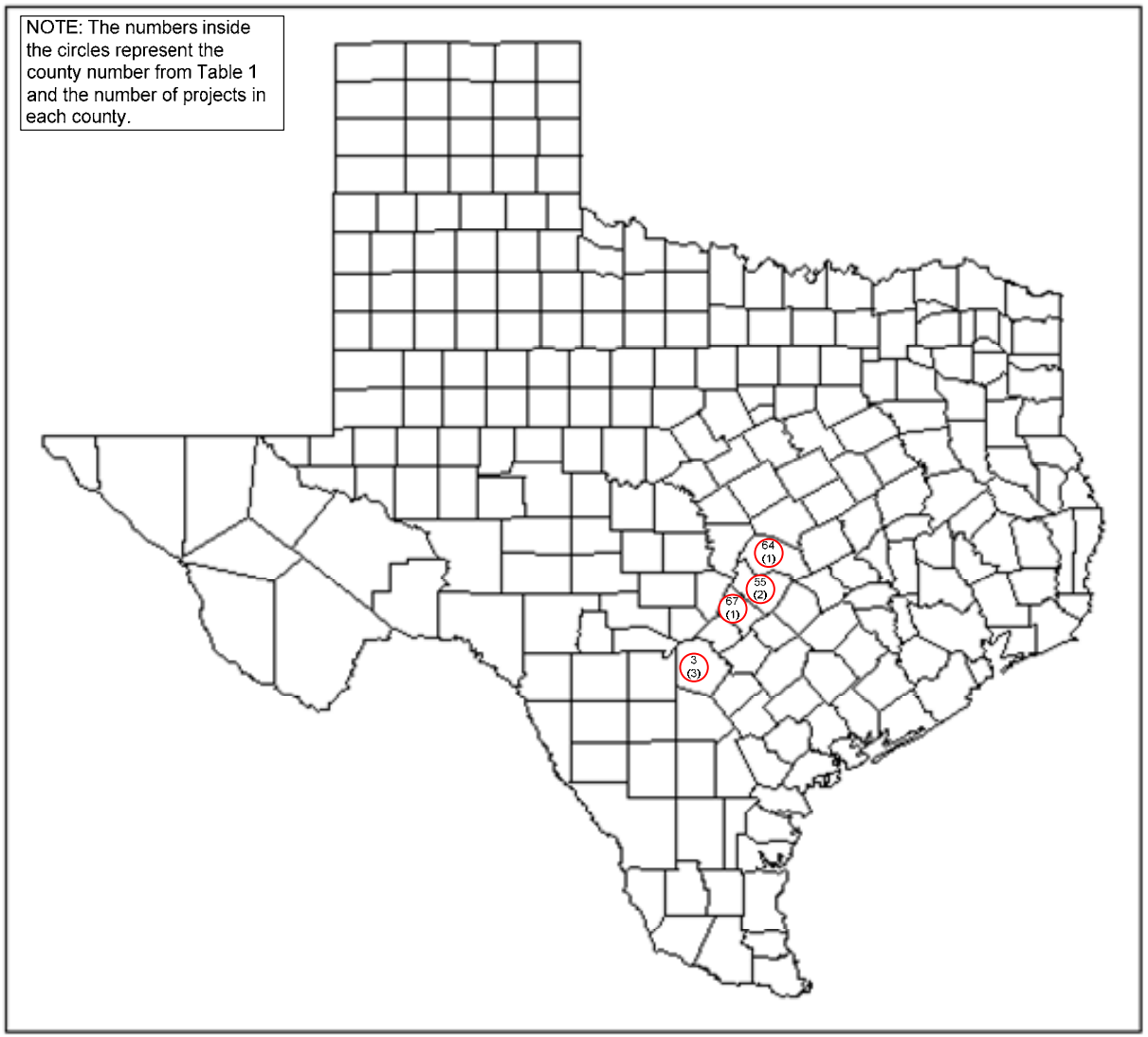

Figure 2. Solar Thermal Projects throughout Texas.

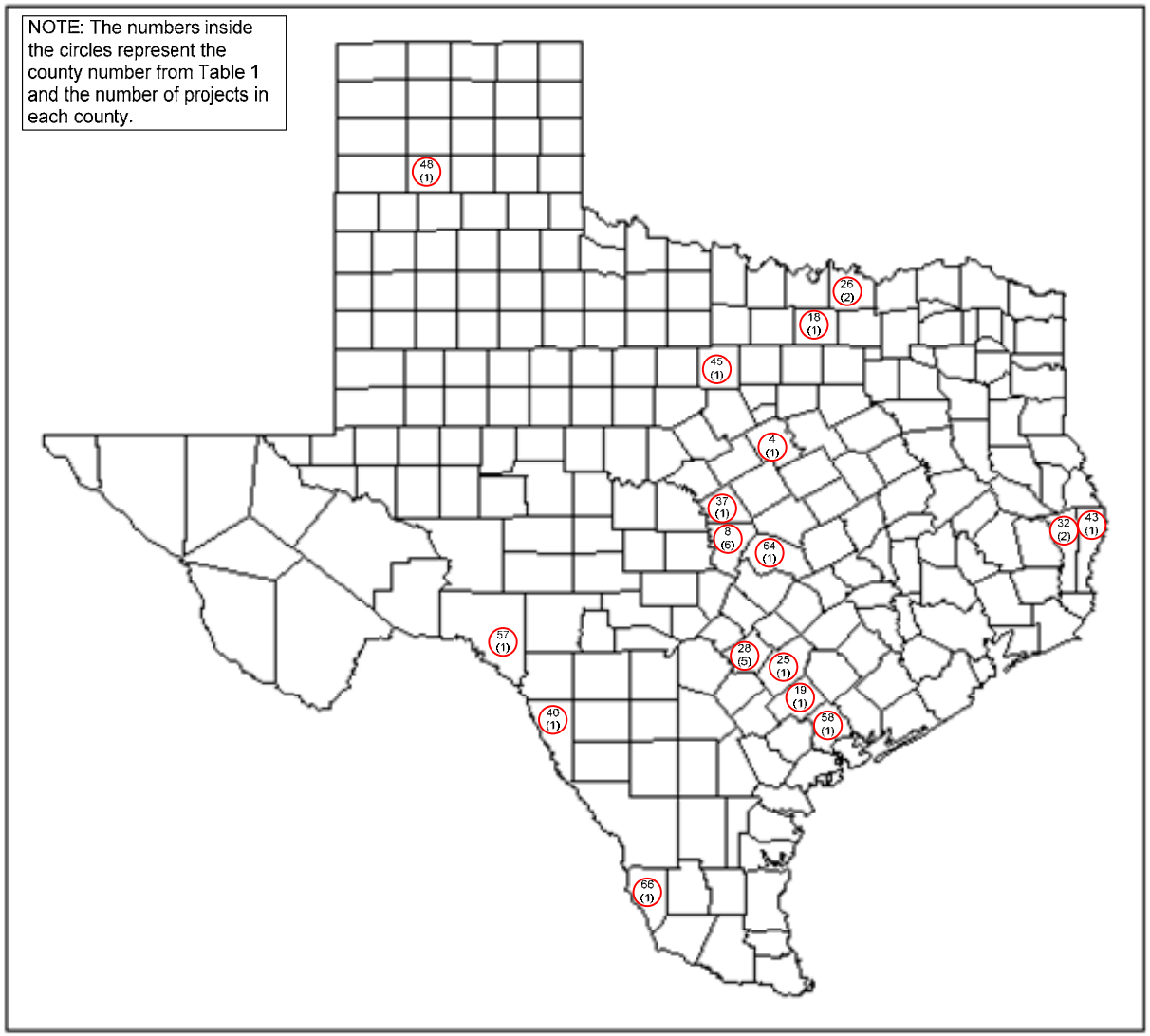

Figure 3. Hydroelectric Plants throughout Texas.

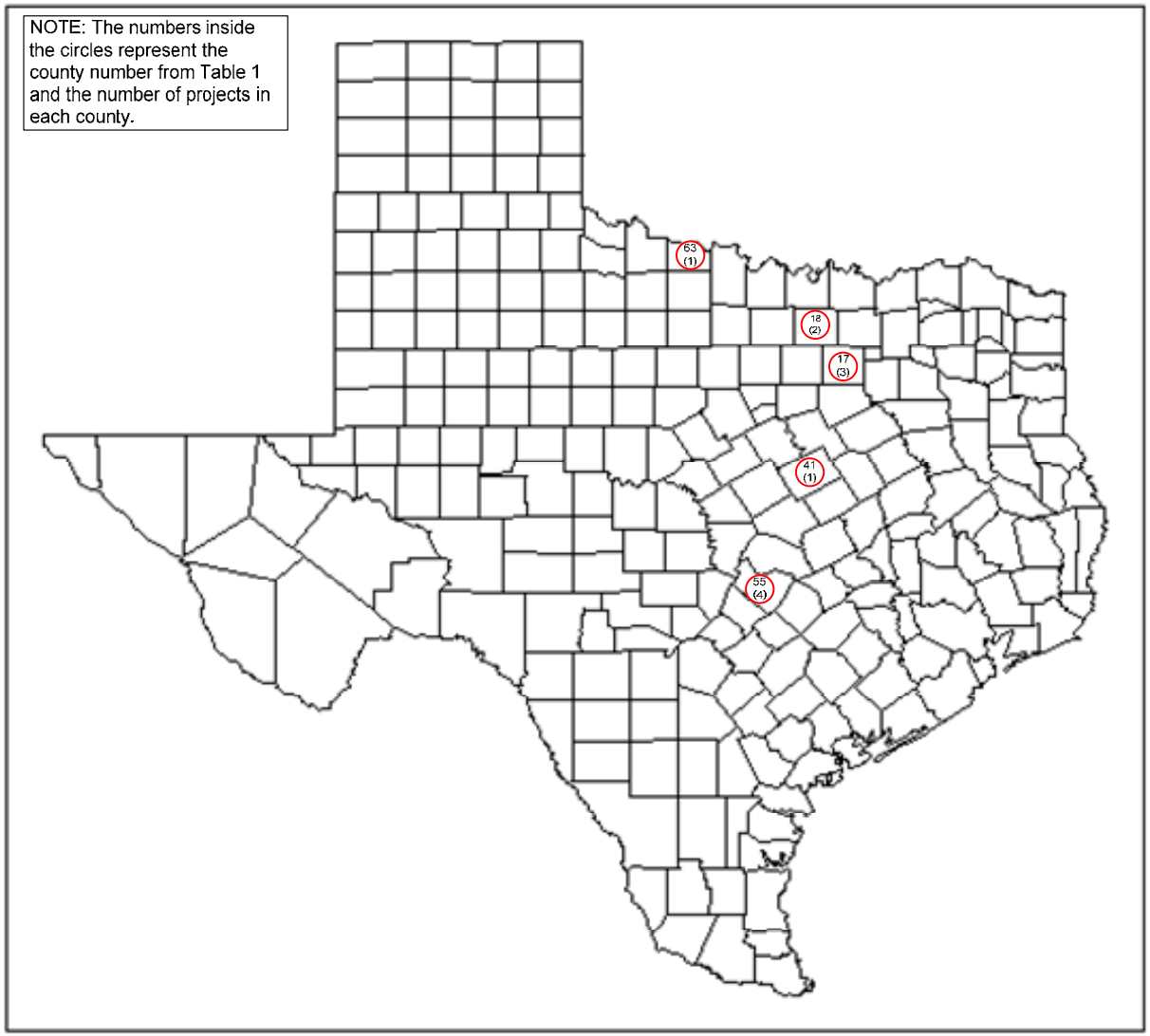

Figure 4. Geothermal Projects Installed throughout Texas.

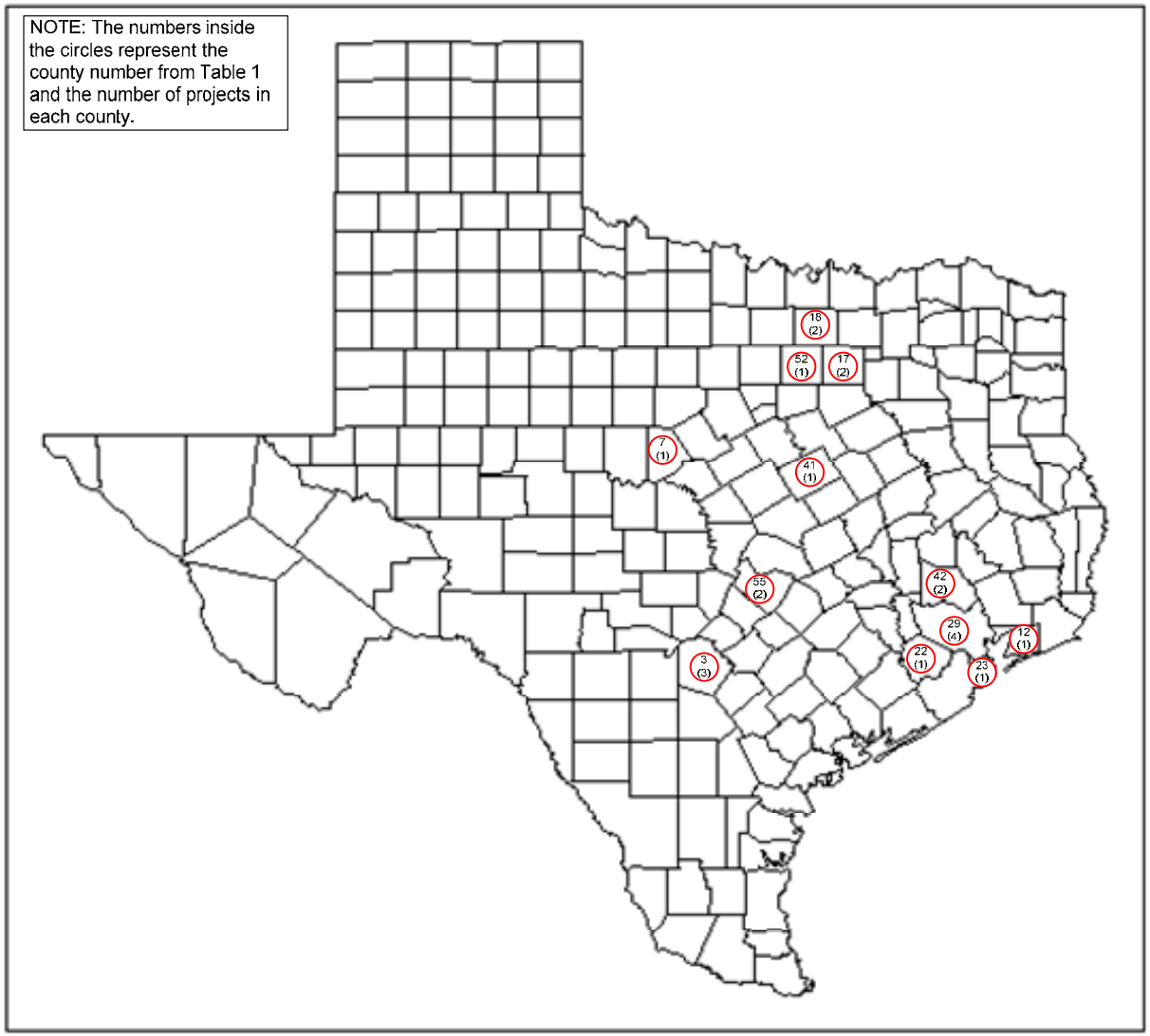

Figure 5. Landfill Gas-fired Power Projects installed throughout Texas.

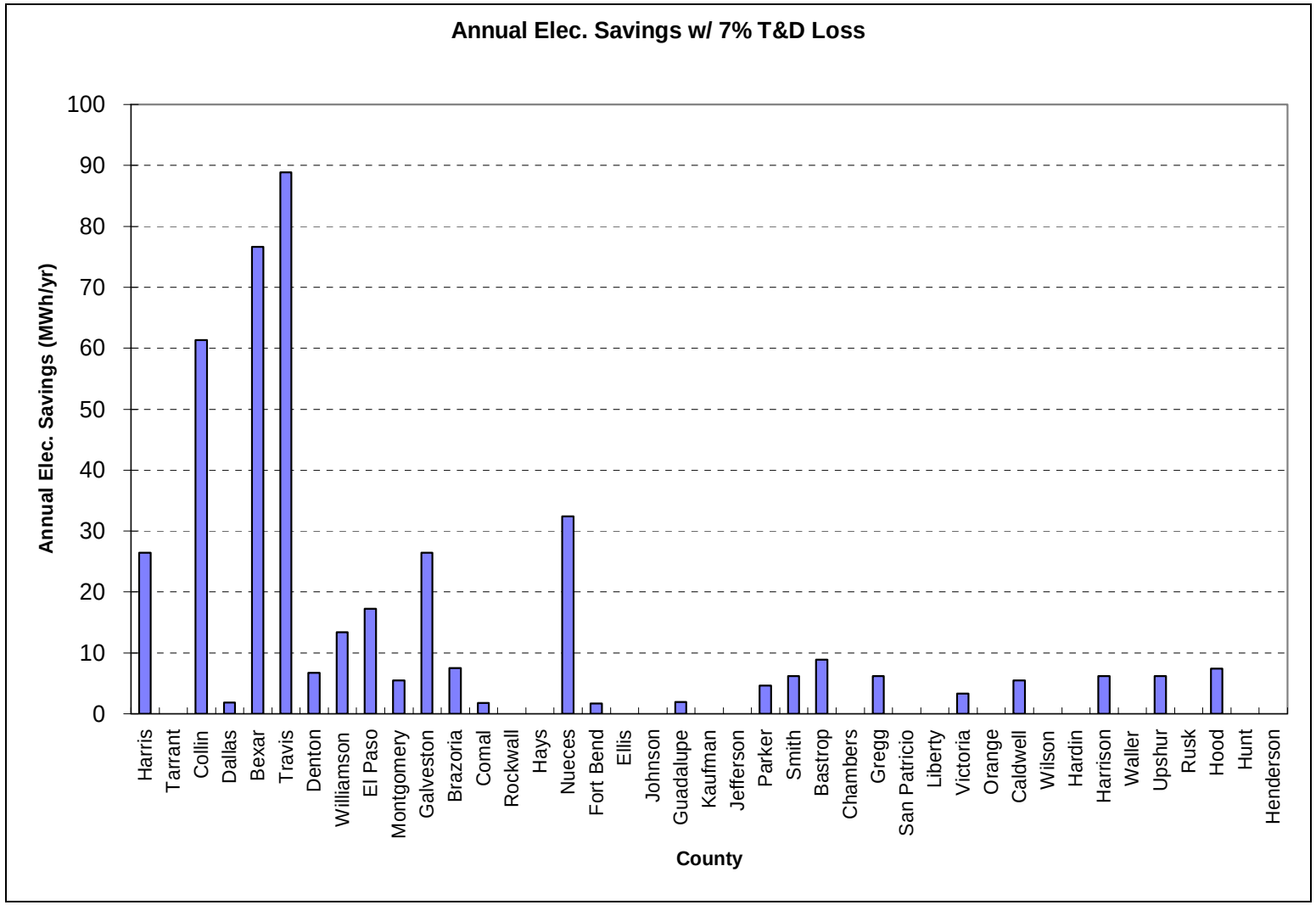

Figure 6. Annual Electric Savings per County from PV Projects.

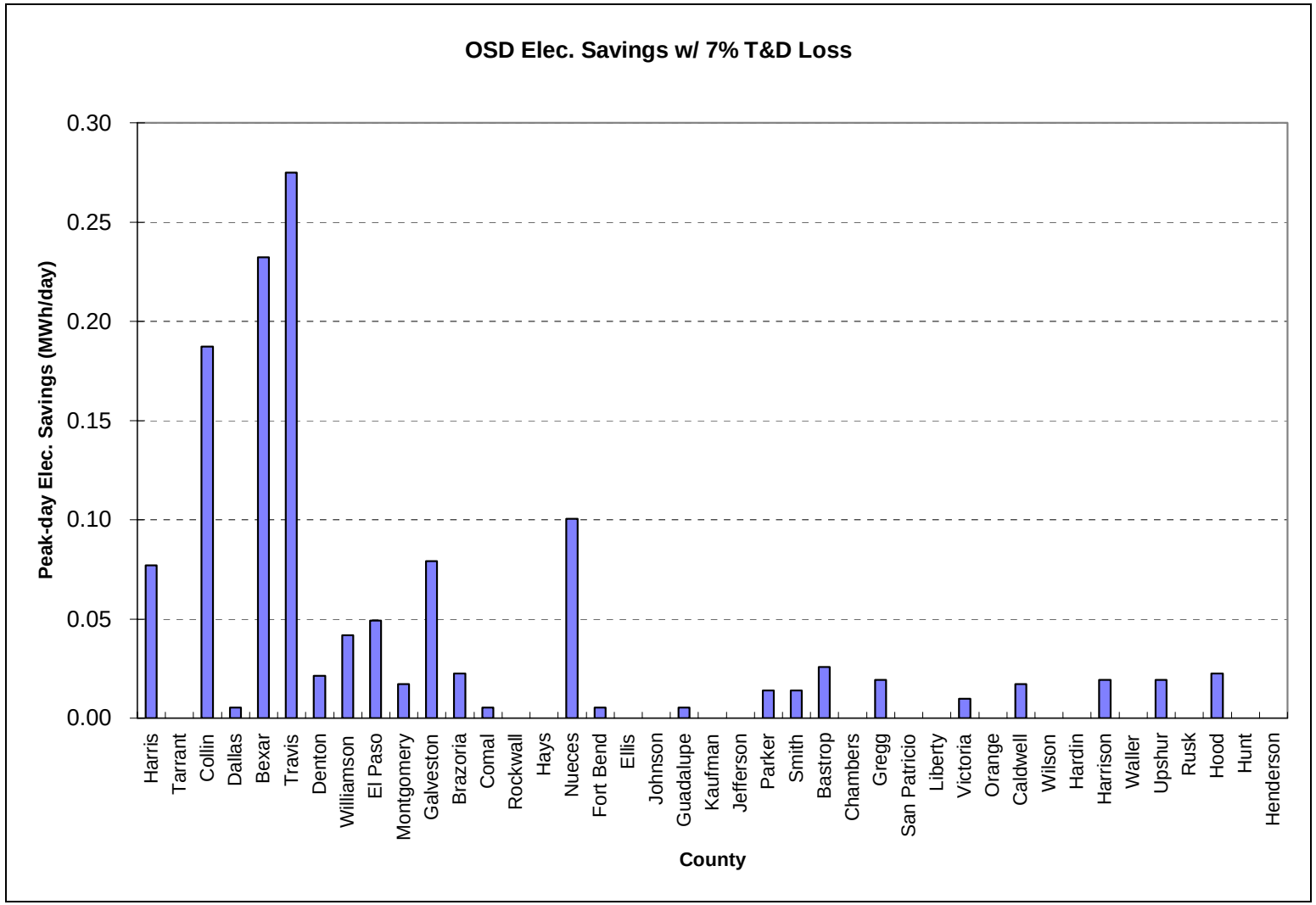

Figure 7. Ozone Season Day Electric Savings per County from PV Projects.

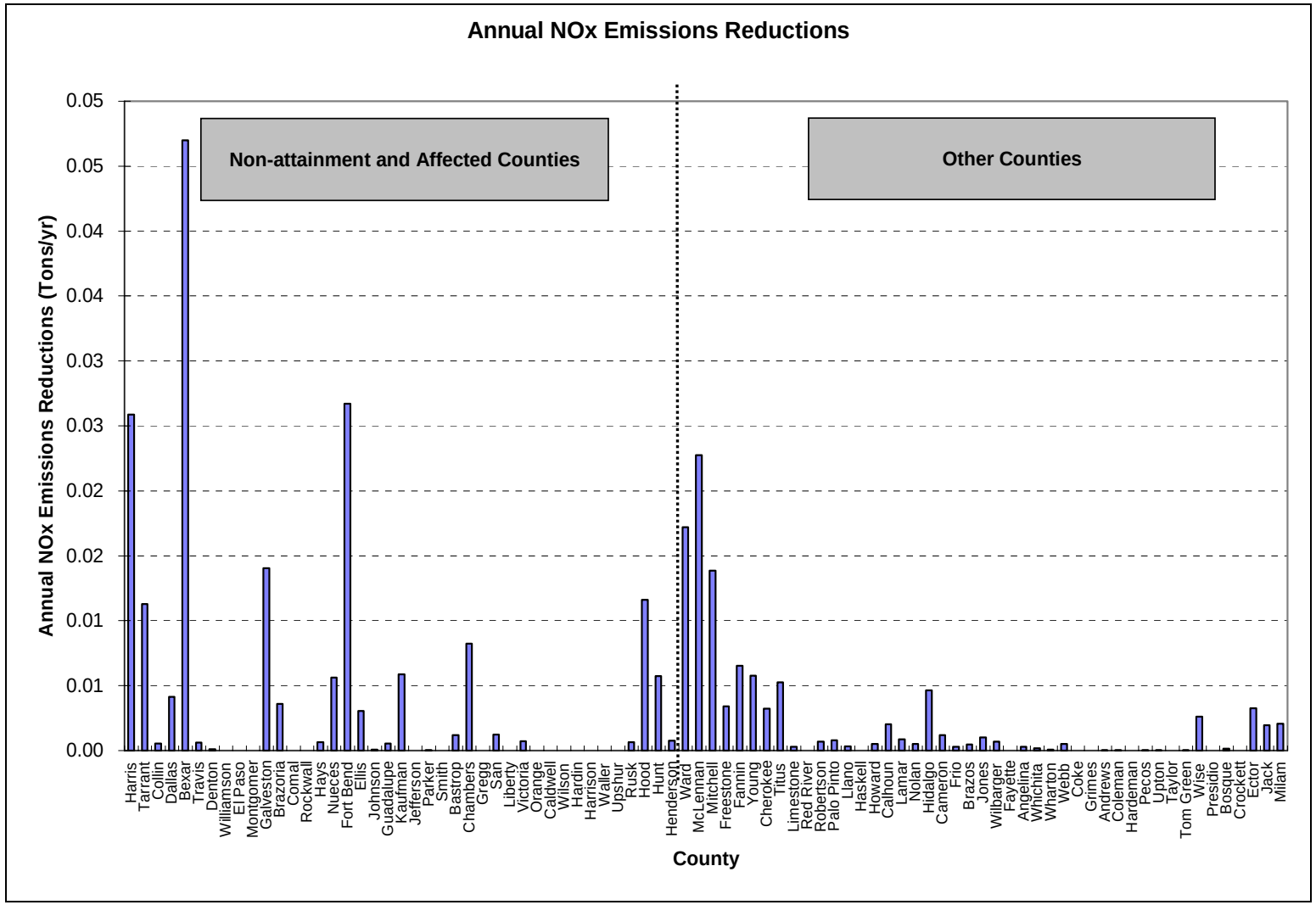

Figure 8. NOx Emissions Reduction per County from PV Projects.

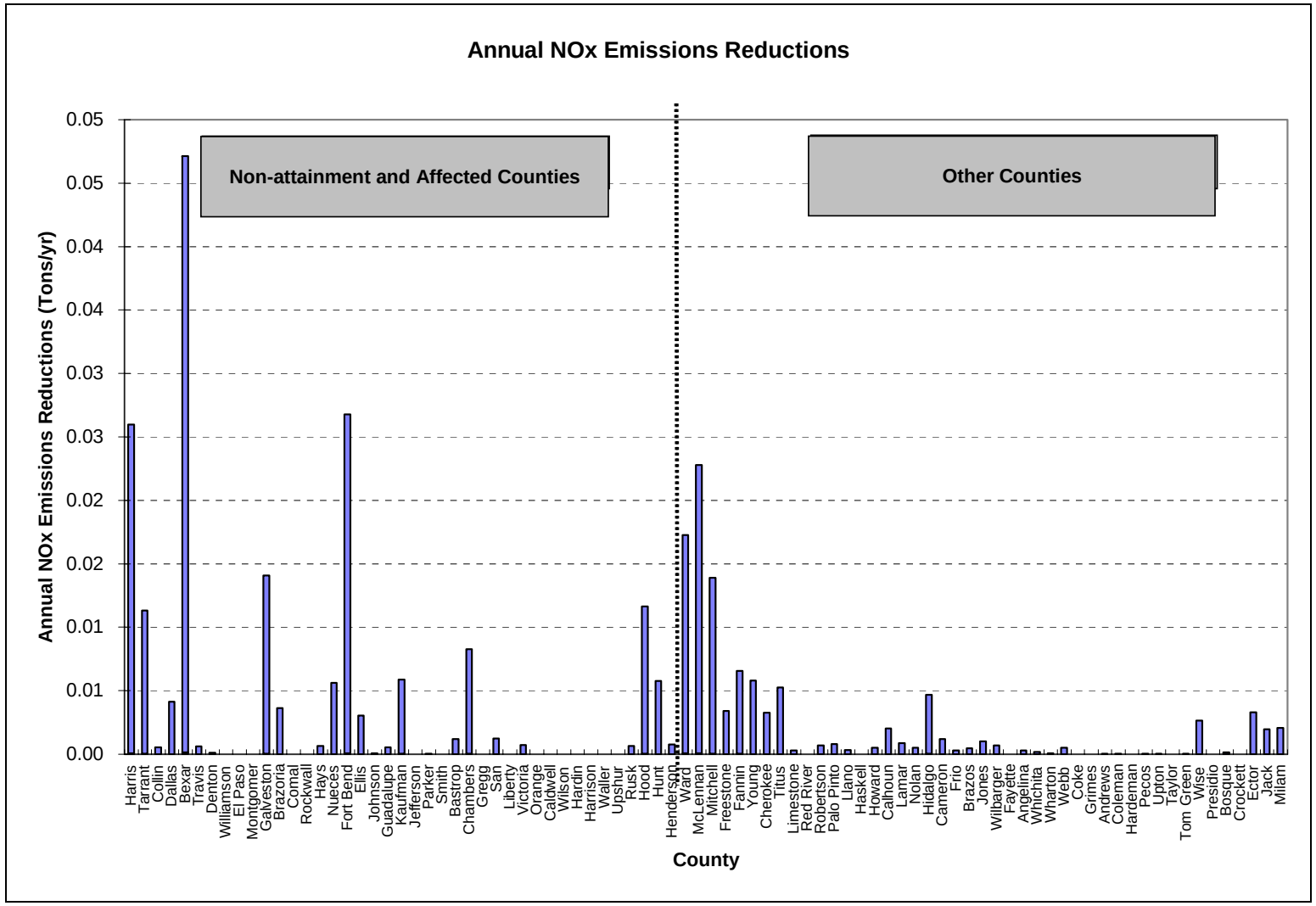

Figure 9. Ozone Season Day NOx Emissions Reduction per County from PV Projects.

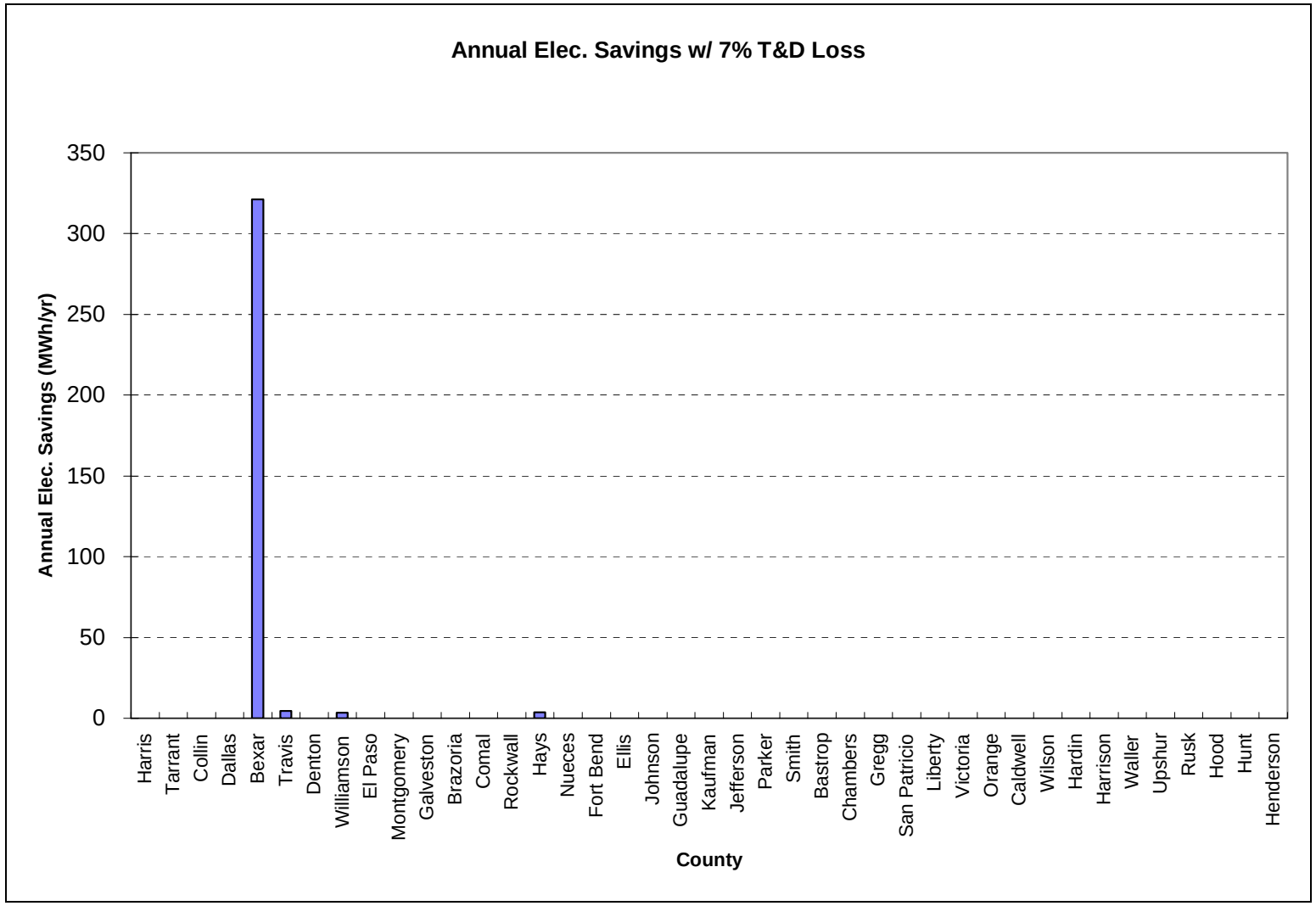

Figure 10. Annual Electric Savings per County from Solar Thermal Projects.

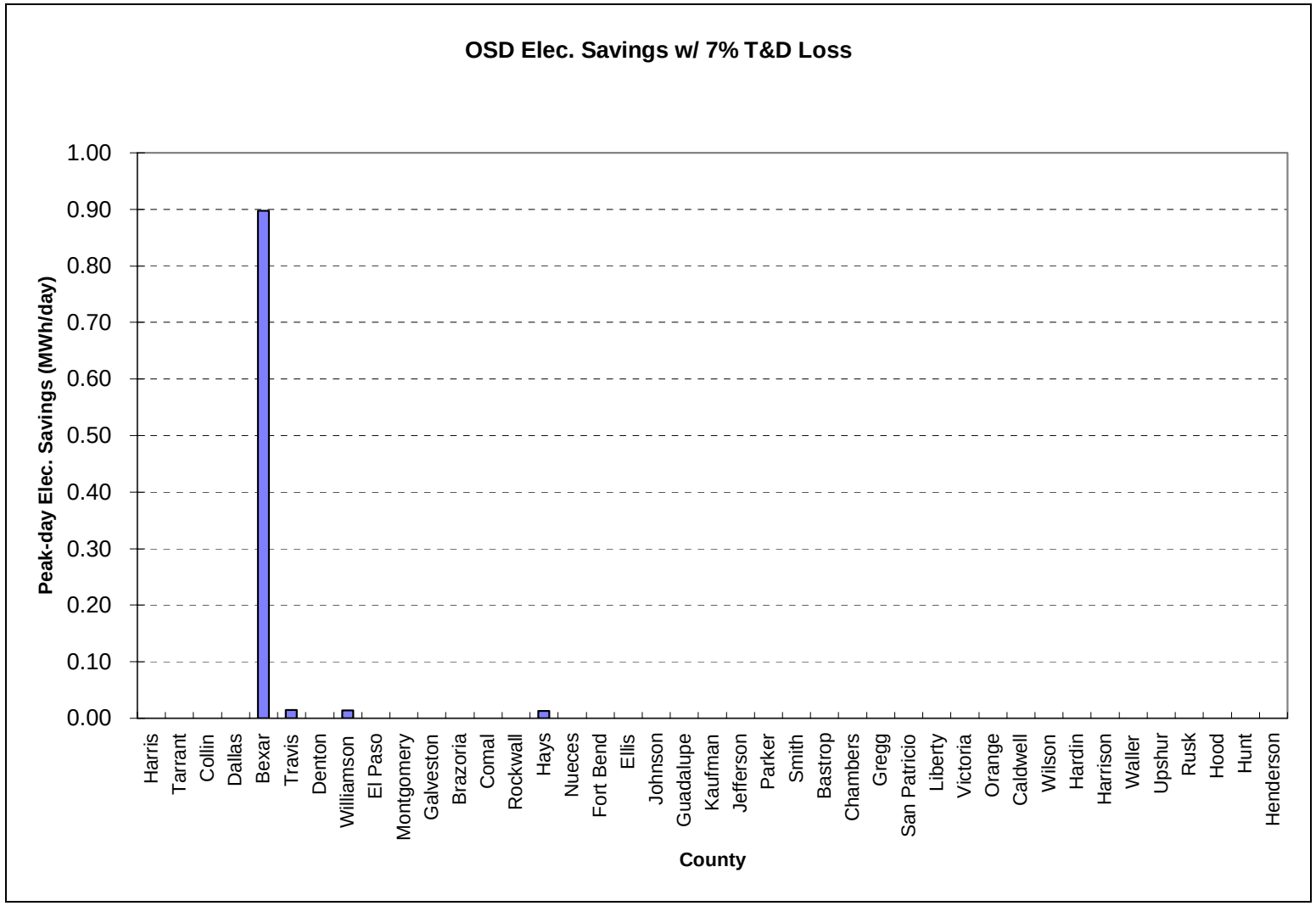

Figure 11. Ozone Season Day Electric Savings per County from Solar Thermal Projects.

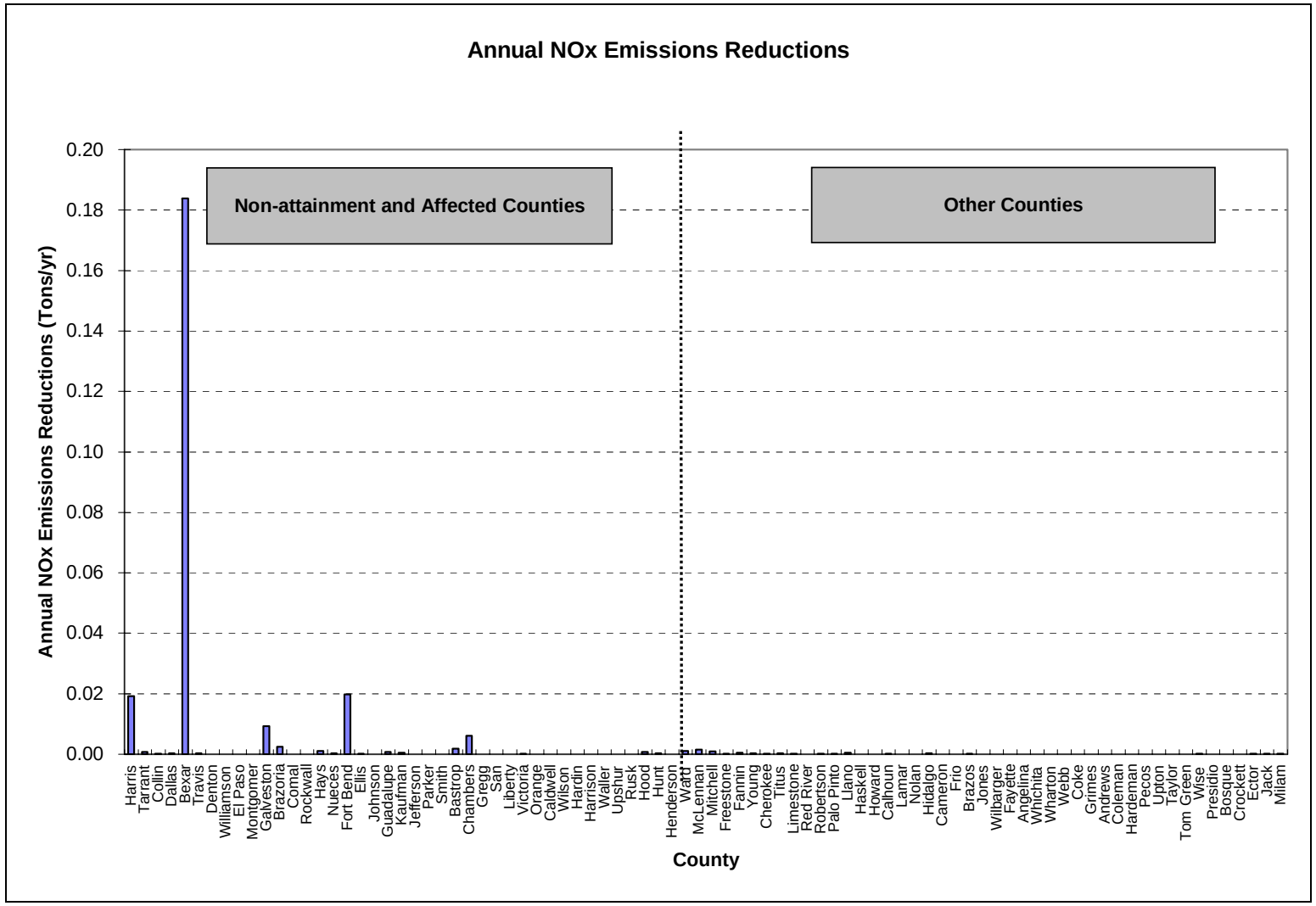

Figure 12. NOx Emissions Reduction per County from Solar Thermal Projects.

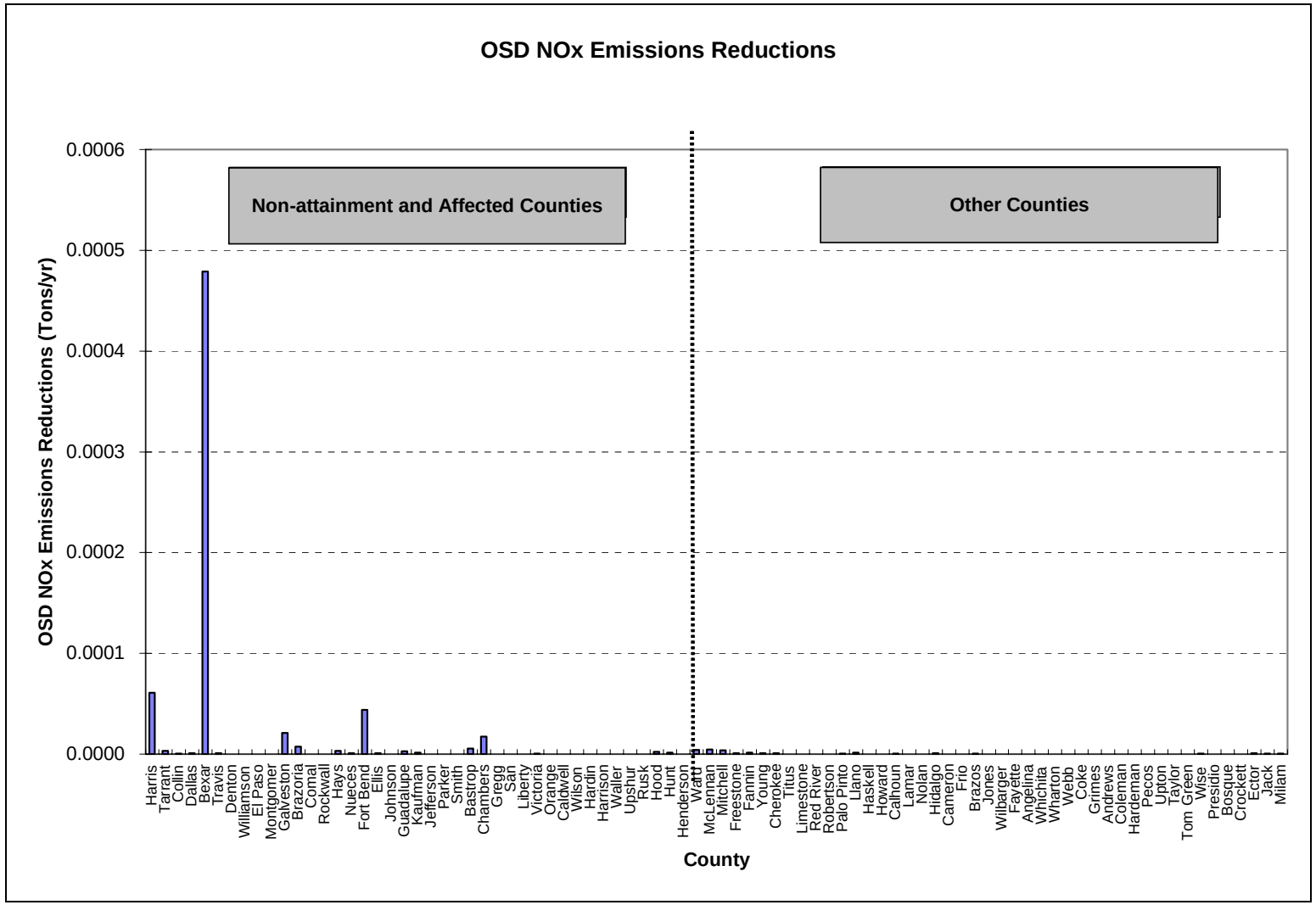

Figure 13. Ozone Season Day NOx Emissions Reduction per County from Solar Thermal Projects.